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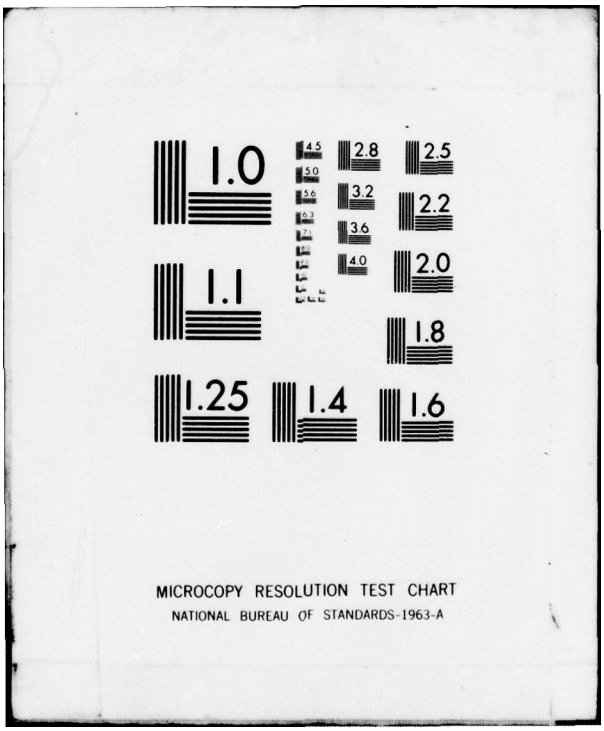
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DESTROYER ENGINEERED OPERATING CYCLE (DDEOC)

System Maintenance Analysis
CG-16 AND CG-26 CLASS
NAVY TACTICAL DATA SYSTEMS
SWAB GROUP 410
SMA 1626-410
REVIEW OF EXPERIENCE
August 1979

Prepared for
Director, Escort and Cruiser
Ship Logistic Division
Naval Sea Systems Command
Washington, D.C.
under Contract N00024-78-C-4062

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This report, the review of experience, documents the historical maintenance experience for both CG-16 and CG-26 Class Navy tactical data systems (NTDS), SWAB group 410. It presents an analysis of the existing maintenance policy and recommends specific maintenance actions and maintenance policy modifications to improve system material condition.

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DESTROYER ENGINEERED OPERATING CYCLE (DDEOC) SYSTEM MAINTENANCE ANALYSIS CG-16 AND CG-26 CLASS NAVY TACTICAL DATA SYSTEMS SWAB GROUP 410 SMA 1626-410 REVIEW OF EXPERIENCE

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Prepared for

Director, Escort and Cruiser
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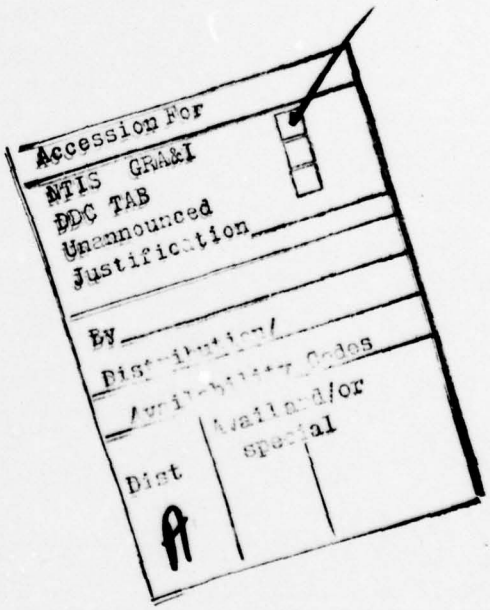
FOREWORD

This report, the review of experience, documents the historical maintenance experience for both CG-16 and CG-26 Class Navy tactical data systems (NTDS), SWAB group 410. It presents an analysis of the existing maintenance policy and recommends specific maintenance actions and maintenance policy modifications to improve system material condition. It has been developed for NAVSEA 931X, the manager of the Destroyer Engineered Operating Cycle (DDEOC) Program, under Navy Contract N00024-78-C-4062.



SUMMARY

The goal of the Destroyer Engineered Operating Cycle (DDEOC) Program is to effect an early improvement in the material condition of ships at an acceptable cost, while maintaining or increasing their operational availability during an extended operating cycle. In support of this goal, system maintenance analyses (SMAs) are being conducted for selected systems and subsystems of designated surface combatants. The principal element of an SMA is the review of experience (ROE). This report documents the ROE for the CG-16 and CG-26 Class Navy tactical data systems (NTDS), SWAB group 410.

The ROE is an analysis of the impact of the historical maintenance requirements on the operational performance and maintenance program of a ship system, and the significance of these requirements to the DDEOC Program. The report documents a recommended system maintenance policy and specific maintenance actions best suited to meeting DDEOC goals.

The ROE for the NTDS included an analysis of all available maintenance data sources. The documented maintenance experience of the system was reviewed through analysis of data from the maintenance data system (MDS), casualty reports (CASREPs), and system overhaul records. Initial findings from these sources were correlated with planned maintenance system (PMS) requirements, the alterations program, and system technical manuals. Selected ships were surveyed and discussions were held with appropriate technical groups to validate identified maintenance requirements, to identify undocumented maintenance requirements, and to determine the status of current and planned actions affecting the NTDS. All findings were evaluated and appropriate conclusions were developed.

A recommended system maintenance policy was defined on the basis of these conclusions and recommendations were then made to implement the policy by periodically accomplishing specific types of corrective maintenance actions. These actions were documented for inclusion as tasks in the CG-16 and CG-26 Class maintenance plans. Also included, as appropriate, were recommendations for improving system preventive maintenance; integrated logistics support; reliability, maintainability, and availability; and depot- and IMA-level capabilities. Implementing these combined recommendations will minimize the impact of corrective maintenance on the extended operating cycle.

The major findings and conclusions of this ROE for the CG-16 and CG-26 Class NTDS are summarized as follows:

- Accomplishment of field changes applicable to the display consoles should reduce the corrective maintenance burden and improve system reliability.
- Reduction of the lead time required to obtain some of the replacement parts for the display consoles should reduce cannibalization of consoles.
- Accomplishment of the refurbishment program for the display consoles and the AN/SRC-16( ) HF transceivers is expected to reduce the corrective maintenance burden for these equipments.
- Replacement of the RD-243/USQ-20(V) magnetic tape recorder with the RD-358(V)/UYK magnetic tape recorder (ShipAlt CG-16-0139 and ShipAlt CG-26-0433) should reduce the corrective maintenance burden and the number of CASREPs, and improve system reliability.
- Replacement of the AN/SRC-31( ) transceivers with the AN/URC-93(V) transceiver (ShipAlt CG-16-1374 and ShipAlt CG-26-0270) should reduce the corrective maintenance burden and number of CASREPs, and improve system reliability.

Most of the equipments in the NTDS complex are generally reliable and, if maintained in accordance with the existing maintenance strategy of performing PMS requirements and "run to failure", are adequate to support the NTDS equipments through an extended operating cycle.

Reliable operation of the NTDS can be expected throughout an extended operating cycle if the recommendations contained in this study are implemented and existing PMS maintenance requirements are adhered to.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

System maintenance analyses (SMAs) are being conducted as part of the Destroyer Engineered Operating Cycle (DDEOC) Programs, managed by NAVSEA 931X. The principal element of an SMA is the review of experience (ROE) of selected systems and subsystems of program-designated surface combatants. This report documents the ROE for the CG-16 and CG-26 Class NTDS, SWAB group 410, which was selected for analysis because equipments of this system have been major contributors to the CG-16 and CG-26 Class maintenance burdens.

1.2 PURPOSE AND SCOPE

The ROE is an analysis of the impact of the historical maintenance requirements on a ship system's operational performance or maintenance program. It serves as a vehicle for documenting the significance of historical maintenance requirements to the DDEOC Program.

The objective of the ROE is to define and document a maintenance program for CG-16 and CG-26 Class ships that will prevent or reduce the need for unscheduled maintenance while improving material condition and maintaining or increasing ship availability throughout an extended ship operating cycle. The maintenance program defined and documented in an ROE for a selected equipment will be the basis for maintenance tasks to be developed for inclusion in the class maintenance plan.

The analysis documented in this report is specifically applicable to the NTDS, SWAB group 410, of the CG-16 and CG-26 Class ships. This analysis utilized all available documented data sources from which system maintenance experience could be identified and studied. These included maintenance data system (MDS) data, casualty reports (CASREPs), Board of Inspection and Survey (INSURV) reports, departure reports, ship's alteration and repair packages (SARPs), planned maintenance system (PMS) requirements data, system alteration documentation, and system technical manuals. Sources of undocumented data used in this analysis included discussions with ship's force and cognizant Navy technical personnel.

1.3 REPORT FORMAT

The remaining chapters of this report describe the analysis approach (Chapter Two), briefly present the significant system maintenance experience and discuss essential maintenance requirements (Chapter Three), and summarize the conclusions and recommendations derived from the analysis (Chapter Four).

CHAPTER TWO

APPROACH

2.1 OVERVIEW

This chapter describes the approach followed in performing the ROE for equipments and subsystems in the Navy tactical data system, SWAB group 410. These systems were identified for analysis in the *DDEOC Selected Items for Analysis List, CG-16 and CG-26 Classes*, ARINC Research Publication 1653-06-TR-1875. Primary data sources were identified in Section 1.2. The data were used to identify, define, and analyze maintenance requirements that have significantly affected the system's operational availability and material condition. A recommended maintenance strategy and implementation procedures were formulated on the basis of analysis results. The major steps of the analysis were as follows:

- Relevant documented and undocumented historical maintenance data were compiled for the selected equipments or subsystems.
- These data were analyzed to identify and define recurring maintenance requirements that have a significant impact on the operational availability and material condition of these equipments or subsystems.
- The results of ROE analyses were compared with results of previously completed analyses of identical or functionally similar equipment or subsystems (on other classes of ships) to determine if previously identified maintenance strategies and implementation recommendations apply to CG-16 and CG-26 Class ships.
- If previously developed maintenance strategies and recommendations were determined to be applicable to similar equipment or subsystems of the CG-16 and CG-26 Class ships, they were identified and documented in this report. CMP tasks previously developed were modified to reflect their applicability to these two ship classes.
- Where previously developed maintenance strategies and implementation recommendations were not applicable to CG-16 and CG-26 Class ships, a detailed maintenance analysis was conducted to develop the maintenance strategy to be recommended and the steps to be employed in implementing that strategy.

2.2 DATA COMPILATION

The analysis began with the compilation of comprehensive data on the maintenance history of the system. The data file assembled consisted of four key elements: an MDS data bank, a CASREP narrative summary, a system overhaul experience summary, and a system ShipAlt summary. A library of appropriate technical manuals, bulletins, and related documented was also assembled. The MDS data bank was compiled by examining all MDS data reported for the CG-16 and CG-26 Classes from 1 January 1970 through 31 December 1977. In the case of the CG-16 Class, MDS data reported between 1 January 1970 and completion of modernization were not considered. Thus the data bank for ships of this class includes only the MDS reported maintenance actions occurring between the end of modernization and 31 December 1977. CASREP information was obtained by reviewing CASREPs submitted against the various NTDS equipments during the data period 1 January 1972 through 31 August 1978. Overhaul information was obtained from authorized SARPs and departure reports for ships of both classes.

2.3 MAINTENANCE DATA ANALYSIS

Recurring maintenance requirements affecting the availability and material condition of subsystems or equipments were identified by screening data obtained from the above-described sources, as well as from ship surveys, discussions with Navy technical personnel, and NAVSEA special-interest programs.

MDS data provided the initial and primary source of information screened. The resulting data base includes all part and labor records, as well as narrative material, describing maintenance actions reported against system components. The purpose of the screening process was to identify maintenance actions that had been reported against the NTDS equipments.

Preliminary analysis of each of the equipments was directed toward determining the historical maintenance profile in terms of reported man-hours per equipment operating year, types of maintenance actions commonly recurring, type and number of repair parts used, CASREP frequency, and past ROH experience. The historical maintenance profile was then compared with similar information developed for identical or functionally similar subsystems or equipments previously subjected to detailed analysis during the performance of ROEs for DDG-37 Class ships. Further analysis was not conducted where the results of this comparison showed that the maintenance profile for the CG-16 or CG-26 Class equipment was essentially the same as that of an identical or functionally similar subsystem or equipment previously analyzed on another ship class. Instead, the maintenance strategy and implementation recommendations developed for the same or similar equipment on a previously analyzed ship class were identified as being applicable to the CG-16 or CG-26 Class ships, as documented in this report.

Where the results of the historical maintenance profile comparison did not reveal a marked similarity, a detailed maintenance requirements engineering analysis was conducted. Initially, man-hours and parts-usage trends

were examined to determine if either parameter increased as a function of time after overhaul, indicating wear-out or deterioration. If no increasing trend was evident, it was assumed that the equipment or subsystem could be expected to continue to operate satisfactorily, exhibiting its current maintenance characteristics throughout an extended operating cycle. If an increasing trend was evident, additional analysis was conducted to identify apparent problems and establish the time at which planned restorative maintenance would be required to prevent an unacceptable increase in maintenance burden and downtime.

Detailed analysis was directed toward defining each recurring significant maintenance requirement in terms of several specific factors: the effect of the maintenance action on the subsystem or equipment, the interval between occurrences of the action, the redundancy of the affected subsystem or equipment, the criticality to mission accomplishment, the resources required to perform the necessary corrective maintenance, and the expected subsystem or equipment downtime.

Once the factors associated with the historically required maintenance actions were identified, the individual types of historical maintenance actions were analyzed to identify an design or maintenance-related problems that would have an impact on the selection of a amiantenance strategy. Solutions were then sought by examining each problem in relation to the extent to which it was recognized and its amenability to established types of corrective action. These analysis criteria are expressed in the following questions:

- Is the problem known to the Navy technical community, and has a solution been proposed or established?
- Will a design change reduce or eliminate the problem?
- Is the problem PMS-related? Can it be reduced or eliminated by changes to PMS? (These changes might include adding or deleting requirements, changing periodicity, or developing material condition assessment tests and procedures.)
- Can the problem be reduced or eliminated by improving the system's integrated logistic support (ILS) at the ship's force level?
- Can the problem be reduced or eliminated by improving intermediate maintenance activity (IMA), or depot-level capabilities?
- Can this problem be reduced or eliminated by revising the existing maintenance strategy?

An affirmative answer to any question resulted in analysis of the effects of the solution and in an estimate, when possible, of the cost to implement the solution. A negative answer prompted the engineer to go to the next question. After all the questions concerning an individual problem were asked, the alternative solutions were evaluated and the most acceptable alternatives defined and documented as recommendations. These recommended solutions to identified design or maintenance-related problems were then considered during the definition of the maintenance strategy. A further series of

implementation recommendations was then formulated to accomplish the objectives of the maintenance strategy selected for the engineered operating cycle (EOC).

2.4 MAINTENANCE PROGRAM DEFINITION

The recommended maintenance program stems directly from the subsystem and equipment maintenance strategies identified by the analysis. The total maintenance program includes both the scheduled and unscheduled preventive maintenance and "engineered" and "qualified" corrective maintenance required to maintain the subsystems and equipments at acceptable levels of material condition and availability over an extended operating cycle. Engineered corrective maintenance comprises those tasks which are well defined and must be accomplished periodically. Qualified tasks are those nonspecific repairs that are likely to be required but cannot be characterized precisely as to nature and frequency.

In development of the implementation recommendations, the results of the analysis were used to identify specific corrective maintenance tasks that would be required periodically. Once these tasks were identified, the frequency of accomplishment, the manpower resources required for accomplishment, and the maintenance level required to perform the work were determined for engineered tasks. Qualified maintenance tasks were also identified on the basis of historical data to reserve blocks of man-hours at specified intervals to complete required but nonspecific Class C repairs on the subsystems or equipments under analysis.

Where appropriate, additional recommendations were developed for improving subsystem or equipment reliability, availability, and maintainability; system preventive maintenance; logistics support; and IMA- or depot-level capabilities.

The steps described in this section effectively define the maintenance program recommended for the subsystems and equipments identified for detailed analysis in this ROE. Recommendations resulting from this analysis will be used to develop the class maintenance plan (CMP).

CHAPTER THREE

ANALYSIS RESULTS

3.1 OVERVIEW

This chapter presents the results of an analysis of the corrective and preventive maintenance experiences for selected items of Navy tactical data system (NTDS) [ship work authorization boundary (SWAB) 410] equipments installed on CG-16 and CG-26 Class ships. Four NTDS equipments were selected for analysis: data display group (SWAB 411-1), data processing group (SWAB 412-1), interface equipment (SWAB 414-1), and digital data communications (SWAB 415-1).

These equipments were selected from the *Selected Items for Analysis Lists, CG-16 and CG-26 Classes* (ARINC Research Publication 1653-06-TR-1875, February 1979) on the basis of these respective contributions to the total class maintenance burden as determined by their individual maintenance burden factor (MBF) rankings. The resulting maintenance burden factors reflect the total annual man-hours devoted to corrective and preventive maintenance of equipments included in a particular SWAB category by the combined ships of the class. The ranking of the SWAB categories represents the corrective and preventive maintenance burden contribution of each SWAB category relative to the total class burden. Three categories of information were used to determine this ranking: (1) the ship's force and intermediate maintenance activity (IMA) corrective maintenance man-hour burden (MBF_{CM}) reported in the maintenance data system (MDS), (2) the annual planned maintenance system (PMS) man-hour burden (MBF_{PM}) as determined from equipment maintenance requirement cards (MRCs), and (3) the average number of man-days required for equipment repair during regular overhaul (ROH) as reported in class repair profiles. A summary of these data for the selected NTDS equipments is presented in Table 3-1, together with their relative corrective and preventive maintenance burden rankings.

Sections 3.2 through 3.5 document the results of the maintenance analyses performed for the selected equipments of the CG-16 and CG-26 Class NTDS.

3.2 DATA DISPLAY GROUP (SWAB 411-1)

The CG-16 and CG-26 Class data display group includes data display consoles, a pulse amplifier/symbol generator, a height-size console, and

Table 3-1. DATA SUMMARY OF SELECTED NTDS EQUIPMENTS FOR THE CG-16 AND CG-26 CLASS SHIPS

SWAB Number	Selected Equipment	Applicable APLs	Corrective Maintenance Burden Rank Within Ship	Preventive Maintenance Burden Rank Within Ship	Class Population	MBF_{CM}* (Man-Hours)	MBF_{PM}** (Man-Hours)	ROH Burden (Man-Days)
			CG-16 Class					
411-1	Data Display Group		16	32				
	OA-7979/UYA-4(V)	78049081 78049077			135	1,808	2,160	0
	AM-4534/UYA-4(V)	52353400			9	51	0	
412-1	Data Processing System		12	13				
	CP-642B/USQ-20(V)	62405445 62405446			27	1,000	1,404	
	CP-789(V)/UYK	62406454 62406444			18	316	1,656	0
	RD-243/USQ-20(V)	81694325			9	256	1,044	
414-1	CV-2036(V)/USQ-20(V)	62762811	†	†	18	979	3,780	
415-1	Digital Data Communications		22	17				
	AN/SRC-16( )	57110800 57110801			5	727	1,840	
	AN/SRC-23A(V)	57112303CL 52379890 88485894			10	135	2,061	104
	AN/SRC-31( )	57113100 57113105 57113110			18	660	630	
	AN/USQ-36	58628400			8	177	1,048	
			CG-26 Class					
411-1	Data Display Group		5	37				
	OA-3953/SYA-4(V)	78044353			56	3,582	560	
	OA-3955/SYA-4(V)	78044355			48	1,070	480	0
	OA-4755/SYA-4(V)	78047430			7	729	304	
	AN/SYA-4(V)	57213055			8	717	379	
412-1	Data Processing System		26	18				
	CP-642A/USQ-20(V)	62405443			24	744	2,088	
	CP-789(V)/UYK	62406454 62406444			16	88	1,744	0
	RD-243/USQ-20(V)	81694325			8	593	931	
414-1	CV-2036(V)/USQ-20(V)	62762811	†	†	8	102	1,680	
415-1	Digital Data Communications		16	30				
	AN/SRC-16( )	57110800 57110801			8	1,558	2,940	
	AN/SRC-31( )	57113100 57113105 57113110			16	1,450	557	185

*Combined average for the reported ship's force and IMA corrective maintenance man-hours expended on a particular equipment per year for the entire class population of that equipment.
**Total required annual PMS man-hours as reflected by appropriate MRCs for the entire class population of that equipment.
†This equipment was originally grouped with data processing equipment.

various supporting equipments (as shown in Table 3-2). The DDG-37 Class data display group configuration is also included in Table 3-2 to show the similarities between the CG-16 and DDG-37 configurations. The corrective maintenance burden comparison between these two classes is addressed in Subsection 3.2.3.

The data display consoles of the data display group are used to display tactical information from various detecting and tracking data sources.

The pulse amplifier/symbol generator provides the data display consoles with amplification and distribution of computer input and output data, as well as with symbols and timing signals.

The height-size console is used to display target range, height, and size information from the AN/SPS-48(A) surveillance radar.

The remaining equipments in the data display group provide for data conversion, data distribution, remote data readouts, communication, test, and simulation.

3.2.1 Data Display Consoles

3.2.1.1 Background

The CG-16 Class ships are each equipped with 15 OA-7979(V)/UYA-4(V) data display consoles. The CG-26 Class ships are equipped with seven OA-3953/SYA-4(V) data input display consoles and six OA-3955/SYA-4(V) data utilization display consoles. The data utilization consoles are physically the same as the data input consoles, but operationally, the data utilization consoles cannot input or change information already being utilized by the operating system; these actions must be made by the data input consoles. As shown in Table 3-2, the equipment configuration for the data display group on a typical ship in the CG-16 Class is the same as that configuration for a typical ship of the DDG-37 Class. All of the data display consoles on the CG-16, CG-26, and DDG-37 Class ships use heat exchangers (connected to an external distilled water system) and a blower to provide the necessary cooling. Because of the functional similarity between the data display consoles on the CG-16 and CG-26 Classes, these consoles will be discussed together.

APLs 78049081 and 78049077 support the data display consoles on the CG-16 and DDG-37 Class ships. APLs 78044353 and 78044355 support the data display consoles on the CG-26 Class ships.

3.2.1.2 Discussion

As shown in Table 3-3, the average man-hours of corrective maintenance per equipment operating year (EOY) for the data display consoles on the CG-16 and DDG-37 are very close, with corrective maintenance burdens of 13.4 and 15.8, respectively. The corrective maintenance burden for the display consoles on the CG-26 Class ships is higher, with values of 64 and 22.3 for the OA-3953/SYA-4(V) and OA-3955/SYA-4(V), respectively.

Table 3-2. TYPICAL CONFIGURATIONS OF THE DATA DISPLAY GROUP FOR THE CG-16, CG-26, AND DDG-37 CLASS SHIPS

Nomenclature	APL	Quantity
CG-16 Class		
Data Display Consoles, OA-7979(V)/UYA-4(V)	78049081 78049077	15
Height-Size Console, OA-7980A/UYA-4(V)	78049056	1
Pulse Amplifier/Symbol Generator, AM-4534/UYA-4(V)	52353400	1
Remote Digital Readout, OA-8337(V)2/UYA-4(V)	78049090	1
Radar Data Distribution Switchboard, SB-2780/UYA-4(V)	85299880	2
Communications Patch Panel, SB-2781/UYA-4(V)	85299881	1
Analog-to-Digital Converters, CV-2095(V)/UYA-4(V)	62766680 62766684	2
Intercommunications Stations, LS-537A/UYA-4(V)	72755438	7
Video Signal Simulator, SM-441(V)2/UYA-4(V)	86544104	1
Module Tester, TS-2460/UYA-4(V)	92216240	1
CG-26 Class		
Data Display Consoles, OA-3953/SYA-4(V) and OA-3955/SYA-4(V)	78044353 78044355	7 6
Height-Size Console, OA-4755/SYA-4(V)	78047430	1
Pulse Amplifier, AM-3377/SYA-4(V)	52337700	1
Symbol Generator, OA-3958/SYA-4(V)	78044358	1
Data Input Readout Console, OA-3954/SYA-4(V)	78044354	4
Data Utilization Readout Console, OA-3956/SYA-4(V)	78044356	7
Radar Signal Distribution Switchboard, SB-1623/SYA-4(V)	85216223	2
Communications Patch Panel, SB-1622/SYA-4(V)	85216222	1
Analog-to-Digital Converters, CV-1321/SYA-4(V)	62764400	2
Intercommunications Stations, LS-482/SYA-4(V)	78044456	5
Video Signal Simulator, SM-319/SYA-4(V)	86541905	1
Module Tester, TS-1780/SYA-4(V)	92178000	1
DDG-37 Class		
Data Display Consoles, OA-7979(V)/UYA-4(V)	78049081 78049077	13
Height-Size Console, OA-7980A/UYA-4(V)	78049056	1
Pulse Amplifier/Symbol Generator, AM-4534/UYA-4(V)	57353400	1
Remote Digital Readout, OA-8337(V)2/UYA-4(V)	78049090	1
Radar Data Distribution Switchboard, SB-2780/UYA-4(V)	85299880	2
Communications Patch Panel, SB-2781/UYA-4(V)	85299881	1
Analog-to-Digital Converters, CV-2095(V)/UYA-4(V)	62766680 62766684	2
Intercommunications Stations, LS-537A/UYA-4(V)	62655438	7
Video Signal Simulator, SM-441(V)2/UYA-4(V)	85544104	1
Module Tester, TS-2460/UYA-4(V)	92216240	1

Table 3-3. COMPARATIVE ANALYSIS OF THE DATA DISPLAY CONSOLES FOR THE DDG-37, CG-16, AND CG-26 CLASS SHIPS

Equipment	Applicable Ships	Class Population	Total Ship Operating Time (Ship Years)	Ship's Force + IMA Corrective Maintenance Man-Hours	Average Corrective Maintenance Man-Hours per EOY*
DDG-37 Class					
OA-7979(V)/UYA-4(V) OA-3953/SYA-4(V) OA-3955/SYA-4(V)	9	117	43.9	9,007	15.8
CG-16 Class					
OA-7979(V)/UYA-4(V) OA-3953/SYA-4(V) OA-3955/SYA-4(V)	9	135	52.4	10,486	13.3
CG-26 Class					
OA-7979(V)/UYA-4(V)					
OA-3953/SYA-4(V)	9	56	60.4	24,036	64.0
OA-3955/SYA-4(V)	9	48	60.4	7,183	22.3

*EOY = Equipment operating year.

Analysis of the MDS and CASREP data for the data display consoles on the CG-16 and CG-26 Class ships indicated similar types of corrective maintenance actions. The corrective maintenance burden for data display consoles on the CG-16, CG-26, and DDG-37 Class ships is primarily associated with the following items:

- High-voltage power supply
- Cathode ray tubes (CRTs)
- CRT deflection units

High-Voltage Power Supply and CRT Deflection Unit

As reported for the DDG-37 Class ships, the problems associated with the high-voltage power supply and the CRT deflection unit (which uses high voltage) are directly related to the heat exchanger. The heat exchanger is located near the CRT deflection unit. Condensation from the heat exchanger tends to collect in the high-voltage area causing arcing, which destroys the printed circuit cards. Conformally coating printed circuit cards in the high-voltage area has been initiated to reduce failures.

NAVSECNORDIV Code 6632C personnel reported that conformal coating has reduced the number of problems with high-voltage arcing. If this field change has not previously been accomplished, it is recommended for accomplishment at BOH.

The problem of high-voltage arcing in the deflection units caused by condensation on the heat exchanger warrants further monitoring. Even though the conformal coating has reduce the problem, the source of the problem (condensation) should be investigated thoroughly with the objective of either redesigning or relocating the heat exchanger or selecting an alternative method of cooling the consoles.

Cathode Ray Tubes (CRTs)

Another problem found in the DDG-37 Class MDS data (as well as in CG-16 and CG-26 Class MDS data) was CRT phosphor coating burning in the display consoles. A field change has been issued for all three ship classes that introduces attenuation in the sweep intensity near the center of the CRT, thereby preventing burning of the phosphor coating. If this field change has not previously been accomplished, it is recommended for accomplishment at BOH.

Discussions with technical personnel in NAVSEC Codes 6178 and 6172B and NAVSECNORDIV Code 6632C indicated that possible reasons for increased reporting of corrective maintenance for the OA-3953/SYA-4(V) and the OA-3955/SYA-4(V) display consoles included the following:

- The AN/SYA-4(V) data display system (CG-26) is approximately seven years older than the AN/UYA-4(V) data display system (CG-16 and DDG-37 Classes)
- Design improvements have been made in the AN/UYA-4(V) data display system to improve reliability and maintainability.

One of the areas on the AN/SYA-4(V) data display consoles that requires increased maintenance is in the high-voltage power supplies. Although the high-voltage power supplies are a significant maintenance problem on the CG-16, CG-26, and DDG-37 Class ships, the design of the older units on the CG-26 Class AN/SYA-4 data display system makes the units more difficult to repair. These consoles are much more difficult to disassemble and repair, thereby adding many hours to the CG-26 Class data display system maintenance burden.

Trending

The possibility of deterioration of the data display consoles on the CG-26 Class ships was investigated by using a computerized trending program to determine if an increasing trend exists in ship's force and IMA corrective maintenance man-hours and in the number of equipment failures since overhaul. The results of this analysis indicated a slight decreasing trend in the number of failures and man-hours per operating year since overhaul.

CASREPs

CASREPs were also analyzed for trends. A CASREP analysis for the OA-3953/SYA-4(V) data input display consoles indicated that six ships submitted a total of ten CASREPs for the data period 1 January 1972 through 1 September 1978. The number of CASREPs varied from 0 to 3 per year and did not occur at regular intervals. An increasing trend in CASREPs was not indicated when compared with time since overhaul. Five of the ten CASREPs were for high-voltage power supplies. A CASREP analysis for the OA-3955/SYA-4(V) data utilization display console indicated that three ships submitted a total of six CASREPs for the entire data period. One ship submitted four CASREPs during a four-year period for high-voltage power supplies (three for the same console). One other ship of the class submitted a CASREP for a high-voltage power supply. The sixth CASREP represented a combination of the low-voltage power supply, focus unit, and trackball unit. There was no indication that CASREPs increased with time since overhaul.

Parts Support

Discussions with NAVSEC and shipyard technical personnel confirmed that because of parts support problems with the data display consoles, one console is frequently cannibalized for parts for others. This problem exists for the CG-16, CG-26, and DDG-37 Class ships.

A CASREP for the DDG-37 Class ships stated that two circuit cards in a console high-voltage power supply had burned and that replacements were not available and had to be manufactured, with delivery not expected for 11 months.

Discussions with NAVSEC technical personnel indicated that the original manufacturer for the circuit boards in the AN/SYA-4 display consoles no longer make the circuit boards. These boards utilize discrete components -- an obsolete technology. Therefore, small companies must be contracted to fabricate replacement boards. These replacement boards have caused problems such as circuitry not matching the orginal schematics and components differing from those orginally used. These problems increase maintenance hours on the AN/SYA-4 display consoles. It is recommended that an investigation be made of the parts support problems for the display consoles with the objective of reducing the long lead-time required for delivery of the display consoles. Resolution of this problem should eliminate cannibalization of other consoles and reduce equipment downtime.

Training

Interviews with Navy technical personnel have indicated problems with NTDS training, ranging from inadequate basic analog troubleshooting and maintenance techniques training for the display technicians to inadequate training in NTDS operational philosophy for the officers.

NAVSECNORDIV Code 6632C personnel reported that technician training for display maintenance has been inadequate. The technicians are having problems with basic analog troubleshooting and with troubleshooting

high-voltage power supplies and sweep circuits. This information was confirmed in an April 1978 NTDS east coast conference. NAVSECNORDIV Code 6632C personnel reported that they had been working with the training activity to emphasize the need for teaching analog troubleshooting techniques.

On the basis of the results of this analysis, it is recommended that basic analog troubleshooting techniques, high-voltage power supplies, and sweep circuits be emphasized in the training activity for the display technicians.

Maintenance Strategy

The existing maintenance strategy for the data display consoles on the CG-16, CG-26, and DDG-37 Class ships consists of performing scheduled PMS requirements and, as necessary, restoring the equipments to a specified functional level. The PMS requirement consists primarily of running programmed operational and functional appraisals (POFAs); these current PMS requirements are considered to be adequate for the three classes of ships.

The PMS contains a cyclic requirement for the shipyard to remove, clean, repair, and test the heat exchangers and blower assemblies for the data display consoles in accordance with MIP TD-68/2-A7 for the CG-16 Class and MIP TD-19/1/76 for the CG-26 Class. This task is a recommended engineered input to the class maintenance plan, to be accomplished at BOH and ROH.

Although the maintenance burden for the data display consoles on the CG-26 Class is greater than that burden for consoles on the CG-16 and DDG-37 Classes, the types of maintenance actions are similar. The greater maintenance burden for the CG-26 Class is primarily attributable to the consoles being an older model than the CG-16 and DDG-37 Classes. Because the trending analysis of maintenance man-hours, failures, and CASREPs did not indicate a deterioration trend after overhaul (a factory refurbishment is planned prior to or at BOH), it is concluded that the consoles can be operated in an extended operating cycle without a detrimental impact.

Refurbishment Program

A turnaround program for refurbishment of the NTDS equipment, which includes the data display consoles, was started in October 1976 with the USS HORNE (CG-30). All ships in the CG-16, CG-26, and DDG-37 Classes are scheduled for this refurbishment, which is to be conducted on a 10-year cycle (±2 years).

The refurbishment program consists of installing all required field changes, replacing all questionable components, replacing the wiring harness as required, and cleaning, painting, and testing to ensure that equipments are in "like new" condition, in accordance with MIL-R-24358 (ships), "Restoration for Shipboard Electronic Equipment".

All ships in the CG-16 and CG-26 Classes are scheduled to complete refurbishment at or prior to BOH. If refurbishment has been completed prior to BOH, those Class C repairs required by POT&I and CSMP results are recommended for accomplishment at BOH and the following ROH.

On the basis of this analysis, the CG-26 Class maintenance burden for the data display consoles is expected to remain higher than the maintenance burden for the consoles on the CG-16 and DDG-37 Classes through the EOC because of the design-related problems incurred in repairing the high-voltage power supplies for the AN/SYA-4 data display system. Although the maintenance burden is expected to be higher on the CG-26 Class, it is expected to be at an acceptable level for this type of equipment. However, this equipment can be expected to perform satisfactorily during an extended operating cycle if maintained in accordance with current PMS requirements. Therefore, the recommended maintenance strategy for the CG-16 and CG-26 Class ships is essentially the same as for the DDG-37 Class, and the maintenance strategy recommendations made in the SMA for the DDG-37 Class are equally applicable to the CG-16 and CG-26 Classes.

3.2.1.3 Recommendations

As a result of this analysis, the following actions are recommended for accomplishment at BOH:

- Accomplish those refurbishments of the display consoles on the CG-16 and CG-26 Class ships as scheduled
- Add the above requirement to the CG-16 and CG-26 Class DDEOC repair requirements for BOH
- If the refurbishment has previously been completed, accomplish those Class C repairs required by POT&I and CSMP results
- Accomplish the following field changes on the display consoles at BOH (if they have not previously been accomplished):
  - Conformally coat the printed circuit cards in the high-voltage area
  - Attenuate the intensity of the CRT sweep near tube center to prevent burning of the CRT phosphor coating

The following actions are recommended to be accomplished on the data display consoles for the CG-16 and CG-26 Class ships for ROH and are recommended inputs to the class maintenance plan:

- Accomplish those Class C repairs to the data display consoles required by POT&I and CSMP results
- Remove, clean, repair, and test heat exchangers and blower assemblies in accordance with MIP TD-68/2-A& (CG-16 Class) and MIP TD-19/1-76 (CG-26 Class)

In addition, the following actions are recommended for integrated logistics support (ILS) and reliability and maintainability:

- Monitor further the problem of high-voltage arcing in the deflection units caused by condensation on the heat exchangers. Although conformally coating the printed circuit boards has reduced the problem, the source of the problem (condensation) should be investigated thoroughly with the objective of either redesigning or relocating the heat exchanger or selecting an alternative method for cooling the consoles.
- Investigate the parts support problems for the display consoles with the objective of reducing the long lead-time required for delivery of the display consoles. Resolution of this problem should eliminate cannibalization of other consoles and reduce equipment downtime.
- Emphasize basic analog troubleshooting techniques, high-voltage power supplies, and sweep circuits in the training activity for the display technicians.

3.2.2 Height-Size Video Display Console OA-4755/SYA-4(V)

The OA-4755/SYA-4(V) display console is used only on the CG-26 Class ships to display range and height information from the AN/SPS-48(A) radar. This information is then entered into the unit computer (CP-642) of the Navy tactical data system (NTDS). A typical CG-26 Class ship uses one OA-4755/SYA-4(V) display console.

The OA-4755/SYA-4(V) height-size console is scheduled for removal from the CG-26 Class ships by ShipAlt 374; the OA-4755/SYA-4(V) will be replaced with the OA-7980A/UYA-4(V) height-size console. ShipAlt 374 is scheduled to be completed on all ships of the CG-26 Class by the end of FY 1980, thus preventing this equipment from having impact on the extended operating cycle. The OA-7980A/UYA-4(V) height-size consoles on CG-16 and DDG-37 Class ships were not on the *Selected Items for Analysis List, CG-16 and CG-26 Classes* because of their relatively low maintenance burden.

3.2.2.1 Recommendations

The existing maintenance strategy of performing the scheduled PMS requirements for the height-size console is adequate and no changes are recommended. No additional intracycle maintenance requirements were identified.

3.2.3 AM-4534/UYA-4(V) Pulse Amplifier/Symbol Generator

The AM-4534/UYA-4(V) pulse amplifier/symbol generator on the CG-16 Class ships provides the data display group AN/UYA-4(V) with the following functions:

- Amplification and distribution of computer input and output data between the display group and the computers

- Generation of symbol waveform and timing signals for the display consoles
- Generation of simulated computer output data for testing and troubleshooting the display group

One AM-4534/UYA-4(V) pulse amplifier/symbol generator is used on each ship of the CG-16 Class.

3.2.3.1 Discussion

The AM-4534/UYA-4(V) pulse amplifier/symbol generator used on the CG-16 Class ships is identical to those previously analyzed on the DDG-37 Class ships.

Analysis of the MDS data indicated that only 294 of the ship's force corrective maintenance man-hours and no IMA man-hours were reported during the data period 1 January 1970 through 30 June 1978. There was an average of 5.6 man-hours of corrective maintenance per component operating year for the AM-4534/UYA-4(V) pulse amplifier/symbol generator on the CG-16 Class ships. (This average man-hour value was derived from a total class population of 9, a total of 294 man-hours of corrective maintenance, and 5.8 average equipment operating years per ship.) By comparison, the AM-4534/UYA-4(V) pulse amplifier/symbol generator on the DDG-37 Class ships had an average of 14.4 corrective maintenance man-hours per component operating year.

In both the CG-16 and DDG-37 Class ships, the corrective maintenance for the AM-4534/UYA-4(V) pulse amplifier/symbol generator was very low, with system alignment and random card failures accounting for the corrective maintenance reported.

There were no CASREPs reported for the CG-16 Class or the DDG-37 Class ships.

Parts-usage analysis indicated a total of $5,500 expended for the entire data period. The part usage was primarily random replacements, with no particular part indicated as a high-usage item.

The existing maintenance strategy for the AM-4534/UYA-4(V) pulse amplifier/symbol generator consists of performing scheduled PMS requirements and, as necessary, restoring the equipment to a specified functional level. The PMS requirement consists of running POFAs in conjunction with the display consoles. The current PMS requirements are adequate and no changes are recommended.

On the basis of the results of this analysis, the AM-4534/UYA-4(V) pulse amplifier/symbol generator is expected to perform satisfactorily during the EOC, provided that the PMS requirements are performed as scheduled and corrective maintenance is performed as necessary.

Review of the BOH repair requirement for the CG-16 Class ships indicated a requirement for a Class B overhaul for the AM-4534/UYA-4(V) pulse amplifier/symbol generator. Because the corrective maintenance burden for this equipment on the CG-16 Class ships was so low (5.6 average man-hours of corrective maintenance per component operating year) and because no CASREPs were reported and only $5,500 in parts usage was expended for the entire data period, it is therefore recommended that the requirement for Class B overhaul be deleted from the DDEOC repair requirements for the CG-16 Class ships.

3.2.3.2 Recommendations

The existing maintenance strategy of performing PMS requirements and performing corrective maintenance as necessary is adequate and no changes are recommended.

On the basis of this analysis it is recommended that the requirement for a Class B overhaul for the AM-4534/UYA-4(V) pulse amplifier/symbol generator be deleted from the DDEOC repair requirements for the CG-16 Class ships.

3.2.4 AN/SYA-4(V) Data Display Group

The data display group, AN/SYA-4(V) is installed only on the CG-26 Class ships. It consists of data display consoles, a symbol generator, a pulse amplifier, special purpose readouts, radar signal distribution switchboards, a communications patch panel, analog-to-digital converters, intercommunications stations, a video signal simulator, and an electronic circuit plug-in unit. The data display consoles were discussed in Subsections 3.2.1 and 3.2.2, and the symbol generator and pulse amplifier were discussed in Subsection 3.2.3. Maintenance actions for the remaining equipments were reported under each equipment's APL and were not selected for analysis because of their insignificant contribution to the overall corrective maintenance burden for the NTDS.

3.2.4.1 Discussion

The AN/SYA-4(V) data display group, APL 57213055, accounted for 4,814 ship's force and IMA corrective maintenance man-hours during the data period 1 January 1970 through 31 December 1977 and had an average of 79.7 man-hours of corrective maintenance per equipment operating year.

Analysis of MDS data for the AN/SYA-4(V) data display group indicated that 70 percent (3,370 man-hours) of the maintenance burden was actually attributed to data display consoles. Maintenance actions for the data display consoles included (1) replacement of all CRTs, (2) complete alignment of the AN/SYA-4 data display group, (3) repair of printed circuit boards for AN/SYA-4 display group, (4) repair of bullnose assemblies on all consoles, (5) installation of field changes, (6) repair of trackball assemblies, and (7) accomplishment of the PMS requirement for cleaning heat exchangers. The remaining maintenance actions reported for the AN/SYA-4(V) data display group included providing wiring lists and documentation for

the NTDS internal communications, repairing spare cards, and accomplishment of unidentified actions (those actions reporting man-hours usage but not having an associated narrative deferring the action). The maintenance actions reported for the AN/SYA-4(V) data display group were primarily for the data display consoles as a group. The types of maintenance actions reported for the AN/SYA-4(V) data display group had also been reported under the individual data display consoles.

Analysis of parts-usage data indicated that 77 CRTs and 9 high-voltage power supplies were the most significant parts used during the data period 1 January 1970 through 31 December 1977. The CRT and high-voltage power supplies were previously discussed in Subsection 3.2.1.

A CASREP analysis for the AN/SYA-4(V) data display group indicated that only one CASREP was submitted during the data period 1 January 1972 through 1 September 1978. This single CASREP represented 53 hours of maintenance on the symbol generator. No parts were required.

A trending analysis was performed on the AN/SYA-4(V) data display group for the CG-26 Class ships to investigate the possibility of an increasing trend in corrective maintenance man-hours and the number of equipment failures since overhaul. The results of this analysis indicated a slight decrease in the number of failures and man-hours since overhaul.

The PMS contains a cyclic requirement for the shipyard to remove, clean, repair, and test the heat exchangers and blower assemblies for all water-cooled equipment in the data display group, in accordance with MIP TD-68/2A-7 (CG-16 Class) and MIP TD-19/1-76 (CG-26 Class). This task is a recommended engineered input to the class maintenance plan, to be accomplished at BOH and ROH.

As previously discussed for the data display consoles, a turnaround program for the refurbishment of the AN/SYA-4(V) data display group on the CG-26 Class ships was started in October 1976 with the USS HORNE (CG-30). All ships in the CG-26 Class are scheduled for completion of this refurbishment by the middle of FY 1980.

Present plans call for this refurbishment program to be conducted on a 10-year cycle. Since minimal maintenance data are available for the post-refurbishment period, an accurate assessment of effectiveness cannot be made at this time. An analysis of post-refurbishment period maintenance data should be performed prior to scheduling another refurbishment.

The results of this analysis indicate that the problems reported under the AN/SYA-4(V) data display group (APL 57213055) are related primarily to data display consoles (discussed previously in Subsection 3.2.1. All equipments in the data display group are expected to perform satisfactorily during the EOC, provided that PMS requirements are performed as scheduled, the factory refurbishment program is completed prior to or at BOH, those Class C repairs required by POT&I and CSMP results are accomplished, and corrective maintenance is performed as necessary.

Review of the BOH repair requirements for the CG-16 and CG-26 Class ships indicated a requirement for a Class B overhaul for the AN/SYA-4(V) and AN/UYA-4(V) data display groups. Because a factory refurbishment is being performed, this requirement can be deleted from the DDEOC repair requirements for the CG-16 and CG-26 Class ships.

No additional PMS requirements or intracycle maintenance requirements have been identified.

3.2.4.2 Recommendations

The following actions are recommended for accomplishment at BOH:

- Perform those refurbishments of the AN/SYA-4(V) and the AN/UYA-4(V) data display groups for the CG-16 and CG-26 Class ships as scheduled.
- Delete the requirement for a Class B overhaul of the data display group from the DDEOC repair requirements for the CG-16 and CG-26 Class ships.

The following recommendations apply to the data display group on the CG-16 and CG-26 Class ships, assuming that the factory refurbishment program was completed prior to or at BOH and are recommended as inputs to the class maintenance plan to be accomplished at ROH:

- Include an engineered task for the shipyard to remove, clean, repair, and test heat exchangers and blower assemblies for all water-cooled equipment in the data display group.
  - •• MIP TD-68/2-A-7 (CG-16 Class)
  - •• MIP TD 19/1-76 (CG-26 Class)
- Include a qualified task for the depot to accomplish those Class C repairs on the data display group equipment required by CSMP and POT&I results.

It is also recommended that a maintenance analysis be performed, using post-refurbishment data, after approximately three years of equipment operation to determine the effectiveness of the refurbishment program.

3.3 DATA PROCESSING (SWAB 412-1)

The equipments selected for analysis from the data processing group, SWAB 412-1, on the CG-16 and CG-26 Class ships consist of the CP-642( )/USQ-20(V) digital data computer, the CP-789(V)/UYK digital computer, and the RD-243/USQ-20(V) magnetic tape unit.

The CP-642( )/USQ-20(V) digital computer is the principal equipment of the NTDS complex. It receives data from associated data input devices and makes data available to selected displays or other output devices.

The CP-789(V)/UYK digital computer is used as a format control unit and, with the beacon video processor (BVP), as a general purpose data processing device.

The RD-243/USQ-20(V) magnetic tape unit is used to store programs and maintenance routines for the CP-642( )/USQ-20(V) digital computer and the CP-789(V)/UYK digital computer.

3.3.1 CP-642( )/USQ-20(V) Digital Data Computer

3.3.1.1 Background

Three CP-642B/USQ-20(V) digital data computers are used on the CG-16 Class ships and three CP-642A/USQ-20(V) digital data computers are used on the CG-26 Class ships. The CP-642A/USQ-20(V) digital data computer was manufactured by UNIVAC, and the CP-642B/USQ-20(V) digital data computer was manufactured by Sylvania. The computers are functionally the same on the CG-16 and CG-26 Class ships and will be discussed together.

The computer consists of 13 chassis (horizontally mounted within one cabinet), an operator's control panel, power supplies, and a cooling system.

The cabinet contains four input/output chassis (A1-A4), three chassis for control and arithmetic logic (A5-A7), one chassis for control and bootstrap memory (A8), and five core memory chassis (A9-A13).

3.3.1.2 Discussion

The CP-642( )/USQ-20(V) digital data computers used on the CG-16 and CG-26 Class ships are functionally similar to those digital data computers previously analyzed on the DDG-37 Class ships. This discussion will demonstrate that the maintenance histories of the CG-16 and CG-26 Class are sufficiently similar to that of the DDG-37 Class to preclude another detailed analysis.

The initial comparison of average man-hours of corrective maintenance per equipment operating year (EOY) (shown in Table 3-4), indicates values of 37.9, 27.6, and 69 for the CG-16, CG-26, and DDG-37 Classes, respectively.

Analysis of the MDS data for the CP-642( )/USQ-20(V) digital data computers on the CG-16 and CG-26 Class ships indicated that the corrective maintenance burden was primarily associated with the control and bootstrap memory (chassis A8) and the core memory (chassis A9-A13). Equipment failures were found to be random and did not increase with time since ROH.

The *System Maintenance Analysis for the DDG-37 Class Navy Tactical Data System (NDTS)*, ARINC Research Publication 1652-03-25-1803, indicated that most of the corrective maintenance burden for the CP-642B/USQ-20(V) digital data computer was as indicated for the CG-16/26 Class (that is, maintenance on chassis A8 - control and bootstrap memory, with maintenance on chassis A9-13 - core memory being the second largest contributor to the corrective maintenance burden).

Table 3-4. COMPARATIVE ANALYSIS OF THE DATA PROCESSING EQUIPMENT FOR THE DDG-37, CG-16, AND CG-26 CLASS SHIPS

Equipment	Applicable Ships	Class Population	Total Ship Operating Time (Ship Years)	Ship's Force + IMA Corrective Maintenance Man-Hours	Average Corrective Maintenance Man-Hours per EOY*
DDG-37 Class					
CP-642B/USQ-20(V) Digital Data Computer	9	27	43.9	9,092	69.0
CP-789(V)/UYK Digital Computer	9	12	43.9	1,245	21.3
CG-16 Class					
CP-642B/USQ-20(V) Digital Data Computer	9	27	52.4	5,797	36.9
CP-789(V)/UYK Digital Computer	9	18	52.4	1,617	15.4
CG-26 Class					
CP-642A/USQ-20(V) Digital Data Computer	9	27	60.4	5,001	27.6
CP-789(V)/UYK Digital Computer	9	15	60.4	811	8.1

*EOY = Equipment operating year.

Analysis of parts-usage data for the CG-16 and CG-26 Class ships did not indicate any particular high-usage parts. The printed circuit cards used in the CP-642( )/USQ-20(V) digital data computers are low-cost (under $50) "throw away" cards. The DDG-37 Class system maintenance analysis indicated high usage for a current-divider circuit card (1N-7440-00-948-8196), but this circuit card did not appear as a high-usage part for the CG-16 and CG-26 Class ships.

CASREP analysis for the period 1 January 1972 through 1 September 1978 indicated that 37 CASREPs were submitted for the CG-16 Class and 29 for the CG-26 Class. Thirty-two were submitted for the DDG-37 Class between 1 July 1973 and 30 September 1977. In all three ship classes, most of the CASREPs were associated with memory-related problems. Less than one CASREP per ship operating year for the CP-642( )/USQ-20(V) digital computer was submitted. No increase in CASREPs with time since ROH was indicated.

The CP-642( )/USQ-20(V) digital data computers on the CG-16 and CG-26 Class ships, as on the DDG-37 Class ships, are water cooled (using heat exchangers and blower assemblies) and require cyclic cleaning, repairing,

and testing by shipyard personnel, in accordance with MIP TD-7/2-87 (CG-16 Class) and MIP TD-7/1-C7 (CG-26 Class). This task is a recommended engineered input to the class maintenance plan, to be accomplished at BOH and ROH.

The current maintenance strategy for the CP-642( )/USQ-20(V) digital data computers on the CG-16 and CG-26 Class ships is the same as the DDG-37 Class ships (that is, perform PMS, run-to-failure, and accomplish those Class C repairs shown to be necessary by the PMS requirements). Class C repairs (as indicated by POT&I and CSMP) during BOH and subsequent ROH will be sufficient to prepare the CP-642( )/USQ-20(V) digital data computers for an extended operating period. A review of available SARPs confirmed that this maintenance strategy is adequate. Therefore, it is recommended that Class C repairs be accomplished to the CP-642( )/USQ-20(V) digital data computers on the CG-16 and CG-26 Class ships (as indicated by POT&I and CSMP results) during BOH and subsequent ROH.

A review of the DDEOC BOH repair requirements for the CG-16 and CG-26 Class ships indicated that there is a requirement for a Class B overhaul for the CP-642( )/USQ-20(V) digital computer. On the basis of this analysis it has been determined that Class C repairs (as indicated by POT&I and CSMP results) during BOH and subsequent ROH will be sufficient to prepare the CP-642( )/USQ-20(V) digital data computers for an extended operating period. Therefore, it is recommended that the requirement for a Class B overhaul for the CP-642( )/USQ-20(V) digital data computer be deleted from the DDEOC BOH repair requirements for CG-16 and CG-26 Class ships.

3.3.1.3 Recommendations

The following BOH recommendations apply to the CP-642( )/USQ-20(V) digital data computers on the CG-16 and CG-26 Class ships:

- Accomplish the removal, cleaning, repairing, and testing of the heat exchangers and blower assemblies in accordance with MIP TD-7/2-87 (CG-16 Class) and MIP TD-7/1-C7 (CG-26 Class).
- Accomplish those Class C repairs required by CSMP and POT&I results.
- Delete the requirement for a Class B overhaul from the DDEOC BOH repair requirements for CG-16 and CG-26 Class ships.

The following recommendations apply to the CP-642( )/USQ-20(V) digital data computers on the CG-16 and CG-26 Class ships and are recommended inputs to the class maintenance plan to be accomplished at ROH:

- Include an engineered task for the shipyard to remove the heat exchanger and blower assemblies for cleaning, repairing, and testing, in accordance with MIP TD-7/2-87 (CG-16 Class) and MIP TD-7/1-C7 (CG-26 Class).
- Include a qualified task to accomplish those Class C repairs required by CSMP and POT&I results.

3.3.2 CP-789(V)/UYK Digital Computer

3.3.2.1 Background

The CP-789(V)/UYK digital data computer is a medium-scale, general purpose, digital data processing device with a maximum storage capacity of 32,768 18-bit binary coded words. This computer is manufactured by UNIVAC and is identical to UNIVAC Model 1218 computers. The computer is air-cooled by five internal blowers. A typical ship of the CG-16 and CG-26 Class has two CP-789(V)/UYK digital computers (the CG-17, -30, and -31 have only one).

3.3.2.2 Discussion

The CP-789(V)/UYK digital computers used on the CG-16 and CG-26 Class ships are identical to those digital computers previously analyzed on the DDG-37 Class ships. This discussion will show that the maintenance histories of the CG-16 and CG-26 Class are sufficiently similar to those of the DDG-37 Class to preclude another detailed analysis.

The initial comparison of average man-hours of corrective maintenance per component operating year (shown in Table 3-4) indicates values of 15.4, 8.1, and 21.3 for the CG-16, CG-26, and DDG-37 Classes, respectively.

Analysis of MDS data for the CP-789(V)/UYK digital computer on the CG-16 and CG-26 Class ships indicated that random failures are primarily caused by memory-related problems.

Analysis of parts-usage data indicated that a memory stack, 2N 2740-00-897-5126, was the most frequently used part. Fifteen memory stacks were replaced on the CG-16 Class ships, six on the CG-26 Class ships, and four on the DDG-37 Class ships. In all cases, these replacements represent less than one memory stack per equipment operating year.

A trending analysis was performed on the CP-789(V)/UYK digital computers for the CG-16 and CG-26 Class ships to investigate the degree of deterioration by determining if an increasing trend existed in ship's force and IMA corrective maintenance since overhaul. However, no deterioration was indicated.

CASREPs were also analyzed for trends. Results of a CASREP analysis indicated that four CASREPs were submitted for the CG-16 Class, three for the CG-26 Class, and two for the DDG-37 Class. There was no indication of deterioration with time from ROH. (Navy technical personnel at NAVSEC Code 6172B and NAVSECNORDIV Code 6632B reported that this computer was one of the most reliable equipments in the NTDS.)

The existing maintenance strategy for the CP-789(V)/UYK digital computer on the CG-16, CG-26, and DDG-37 Class ships consists of performing scheduled PMS requirements and, as necessary, restoring the equipment to a specified functional level. The PMS requirement consists primarily of running programmed operational and functional appraisals (POFAs) and is adequate for the current maintenance strategy.

Although the exhibited maintenance burdens for the CG-16 and CG-26 Class ships were less than those of the DDG-37 Class ships, the types of corrective maintenance actions were the same as for the DDG-37 Class ships. Because the trending analysis of maintenance man-hours and CASREPs did not indicate a deteriorating trend after overhaul, it is concluded that the digital computer can be operated in an extended operating cycle without a detrimental impact.

On the basis of the results of this analysis, the CP-789(V)/UYK digital computer on the CG-16/26 Class ships is expected to perform satisfactorily during the EOC, provided that the PMS requirements are performed as required and corrective maintenance is performed as necessary. Therefore, the recommended maintenance strategies for the CG-16 and CG-26 Class ships are essentially the same as the DDG-37 Class (that is run-to-failure, perform PMS, and accomplish those Class C repairs shown to be necessary by POT&I and CSMP results).

Review of the BOH repair requirements for the CG-16 Class ships indicated a requirement for a Class B overhaul of the CP-789(V)/UYK digital computer. On the basis of this analysis, it has been determined that Class C repairs (as indicated by POT&I and CSMP results) during BOH and subsequent ROH will be sufficient to prepare the CP-789(V)/UYK digital computer for an extended operating period. Therefore, it is recommended that the requirement for a Class B overhaul for the CP-789(V)/UYK digital computer be deleted from the DDEOC BOH repair requirements for the CG-16 Class. This requirement did not appear in the DDEOC BOH repair requirements for the CG-26 Class.

3.3.2.3 Recommendations

The following BOH recommendations apply to the CP-789(V)/UYK digital computer on the CG-16 and CG-26 Class ships:

- Accomplish those Class C repairs shown to be necessary by POT&I and CSMP results.
- Delete the requirement for BOH from the CG-16 Class DDEOC repair requirements.

The following recommendation applies to the CP-789(V)/UYK digital computer on the CG-16 and CG-26 Class ships and is a recommended input to the class maintenance plan to be accomplished at ROH: include a qualified task to accomplish those Class C repairs shown to be necessary by POT&I and CSMP results.

3.3.3 RD-243/USQ-20(V) Magnetic Tape Unit

3.3.3.1 Background

The CG-16 and CG-26 Class ships each have an RD-243/USQ-20(V) magnetic tape unit. This tape unit consists of a control module and a tape transport module that contains two model 906-II-1 tape transports manufactured by the Potter Instrument Company, Inc. The RD-243/USQ-20(V) magnetic tape unit has been used with the NTDS since 1961.

3.3.3.2 Discussion

The presently installed RD-243/USQ-20(V) magnetic tape unit is scheduled to be replaced with the RD-358(V)5/UYK, in accordance with ShipAlt CG-16-01329 and ShipAlt CG-26-00433. These ShipAlts are currently scheduled to be accomplished during BOH for the CG-16 and CG-26 Class ships.

The RD-358(V)5/UYK magnetic tape unit is a seven-track, two-transport, water-cooled unit utilizing vacuum columns for tape handling, instead of the mechanical system utilized on the RD-243/USQ-20(V). Replacement of the RD-243/USQ-20(V) with the RD-358(V)5/UYK should significantly reduce the mechanical alignment problems that now account for many hours of preventive and corrective maintenance.

A maintenance analysis was not accomplished for the RD-358(V)5/UYK because of the lack of maintenance history data. However, on the basis of past experience with similar equipments, a qualified task is recommended for the class maintenance plan to remove the heat exchangers and blower motors for inspection and corrective maintenance (as required) by a repair facility. A qualified task is also recommended to accomplish those Class C repairs required by POT&I and CSMP results.

3.3.3.3 Recommendations

On the basis of past experience with similar equipments, the following qualified tasks are recommended as inputs to the class maintenance plan to be accomplished at ROH:

- Include a qualified task for the depot to remove the heat exchangers and blower motors from the RD-358(V)5/UYK magnetic tape recorders for inspection and corrective maintenance (as required) by a repair facility.
- Include a qualified task for the depot to accomplish those Class C repairs on the RD-358(V)5/UYK magnetic tape recorder required by CSMP and POT&I results.

3.4 INTERFACE EQUIPMENT (SWAB 414-1) -- CV-2036(V)/USQ-20(V) DIGITAL DATA CONVERTER

The CV-2036(V)/USQ-20(V) digital data converter, which is also referred to as the keyset control multiplexer (KCMX), is the only equipment in SWAB 414-1 that was selected for analysis. This equipment was reported in the *Selected Equipments for Analysis List, CG-16 and CG-26 Classes*, under SWAB 412-1.

3.4.1 Background

Two CV-2036(V)/USQ-20(V) digital data converters are used on the CG-16 Class ships; one is used on the CG-26 Class ships. These converters are functionally the same on the CG-16 and CG-26 Class ships and will be discussed together.

The CV-2036(V)/USQ-20(V) digital data converter is an interface device that controls the traffic to and from the computers and peripheral devices and also converts keyset data, ship movement data, and missile fire control system data to a form usable by the computer; it also similarly converts data from the computer for the missile fire control system. The CV-2036(V)/USQ-20(V) acts as a traffic control, establishing priorities and traffic routing both into and out of the computer. It also provides a route for transmission of control and status signals between digital computers and other control systems.

3.4.2 Discussion

The CV-2036(V)/USQ-20(V) digital data converters on the CG-16 and CG-26 Class ships are functionally similar to those digital data converters previously analyzed on the DDG-37 Class ships. This discussion will show that the maintenance histories of the CG-16 and CG-26 Classes are similar to those of the DDG-37 Class.

The initial comparison of average man-hours of corrective maintenance per equipment operating year (EOY) (shown in Table 3-5) indicated values of 31.7, 11.6, and 26.8 for the CG-16, CG-26, and DDG-37 Classes, respectively.

Analysis of the MDS data for the CV-2036(V)/USQ-20(V) digital data converters on the CG-16 Class ships indicated that one ship (CG-20) accounted for 41 percent (1,353 hours) of the maintenance burden during the five-year period with only 28 maintenance actions. The other eight ships in the class accounted for an average of 246 hours of maintenance burden during the same data period. The same ship accounted for 50 percent (six) of the CASREPs. The maintenance actions were random failures, usually found by running POFAs. Replacement of circuits cards was the most common solution to the problems that were encountered.

Analysis of the MDS data for the CV-2036(V)/USQ-20(V) digital data converters on the CG-26 Class ships indicated only 700 man-hours of corrective maintenance during the entire data period. Ninety percent of the maintenance burden was reported by four ships. The maintenance burden indicated for the CG-16 Class ships included random circuit card failures. Only one CASREP was reported for the digital data converter on the CG-26 Class ships.

Analysis of parts-usage data for the CG-16 and CG-26 Class ships did not indicate any specific high-usage parts. The printed circuit cards used in the CV-2036(V)/USQ-20(V) digital data converters are low-cost (under $50) "throw away" cards. The DDG-37 Class system maintenance analysis indicated high usage for a series analog-gate circuit card (1N-7440-00-883-8884); but these did not appear as a high-usage part for the CG-16 and CG-26 Class ships.

The existing maintenance strategy for the CV-2036(V)/USQ-20(V) digital data converters on the CG-16 and CG-26 Class ships consists of performing scheduled PMS requirements and, as necessary, restoring the equipment to

Table 3-5. COMPARATIVE ANALYSIS OF THE DIGITAL DATA CONVERTERS FOR THE DDG-37, CG-16, AND CG-26 CLASS SHIPS

Equipment	Applicable Ships	Class Population	Total Ship Operating Time (Ship Years)	Ship's Force + IMA Corrective Maintenance Man-Hours	Average Corrective Maintenance Man-Hours per EOY*
DDG-37 Class					
CV-2036(V)/USQ-20(V) APL 62762811	9	11	43.9	1,437	26.8
CG-16 Class					
CV-2036(V)/USQ-20(V) APL 62762811	9	18	52.4	3,318	31.7
CG-26 Class					
CV-2036(V)/USQ-20(V) APL 62762811	9	9	60.4	700	11.6

*EOY = Equipment operating year.

a given functional level. The PMS requirements consist primarily of running POFAs. The current maintenance strategies for the CV-2036(V)/USQ-20(V) digital data converters on the CG-16 and CG-26 Class ships are essentially the same as for the DDG-37 Class, which is run-to-failure, perform PMS, and accomplish those overhauls and repairs shown to be necessary by POT&I and CSMP results.

The CV-2036(V)/USQ-20(V) digital data converters on the CG-16 and CG-26 Classes are similar to those on the DDG-37 Class ships in that they are water-cooled and require the heat exchangers and blower assemblies to be removed for cyclic cleaning, repairing, and testing by the shipyard personnel, in accordance with MIP TD-50/1-28. This task is a recommended engineered input to the class maintenance plan, to be accomplished at BOH and ROH.

Although the exhibited maintenance burden for the CG-16 Class was slightly greater and the CG-26 Class significantly lower than the reported maintenance burden for the DDG-37 Class ships, the types of corrective maintenance actions were the same as for the DDG-37 Class ships. Therefore, the recommendation for maintenance of the CV-2036(V)/USQ-20(V) digital data converters on the CG-16 and CG-26 Class ships is the same as that for DDG-37 Class ships, which is to accomplish those Class C repairs at ROH shown to be necessary by POT&I and CSMP results.

Review of the repair requirements for BOH for the CG-16 Class ships indicated a requirement for a Class B overhaul of the CV-2036(V)/USQ-20(V) digital data converter. On the basis of this analysis it has been determined that those Class C repairs indicated by POT&I and CSMP results that

are accomplished during BOH and subsequent ROH will be sufficient to prepare the CV-2036(V)/USQ-20(V) digital data converters for an extended operating period. Therefore, it is recommended that the requirement for a Class B overhaul of the CV-2036(V)/USQ-20(V) digital data converter be deleted from the DDEOC BOH repair requirements for the CG-16 Class ships.

On the basis of the results of this analysis, the CV-2036(V)/USQ-20(V) digital data converter is expected to perform satisfactorily during the EOC, provided that the PMS requirements are performed as scheduled and corrective maintenance is performed as necessary.

3.4.3 Recommendations

The following recommendations apply to the CV-2036(V)/USQ-20(V) digital data converters on the CG-16 and CG-26 Class ships and are recommended for accomplishment at BOH:

- Accomplish those Class C repairs shown to be necessary by CSMP and POT&I results
- Accomplish removal, cleaning, repairing, and testing of heat exchangers and blower assemblies in accordance with MIP TD-50/1-28
- Revise the CG-16 Class DDEOC repair requirements for BOH to delete the requirement for a Class B overhaul

The following recommendations apply to the CV-2036(V)/USQ-20(V) digital data converters on the CG-16 and CG-26 Class ships and are recommended inputs to the class maintenance plan to be accomplished at ROH:

- Include a qualified task to accomplish those Class C repairs shown to be necessary by CSMP and POT&I results
- Include an engineered task for the shipyard to remove, clean, repair, and test heat exchangers and blower assemblies, in accordance with MIP TD-50/1-28

3.5 DIGITAL DATA COMMUNICATIONS (SWAB 415-1)

The AN/SRC-16 transceivers (APLs 57110800 and 57110801) and the AN/SRC-23 transceivers (APLs 57112303CL, 52379890, and 88485894) are used on the CG-16 Class ships for data transfer in the HF spectrum (2 to 30 MHz) at 1 kW output power. This data link is referred to as the "A link" or "Link 11" for the NTDS. The CG-26 Class ships use the AN/SRC-16 transceivers (APLs 57110800 and 57110801).

The AN/SRC-31 transceiver (225 to 400 MHz) is the primary equipment for operation of the NTDS "Link 4" (ship/air/ship) on both the CG-16 and CG-26 Class ships.

The AN/USQ-36(V) data terminal set furnishes the channeling and control functions for the "A link" of the NTDS. This system is currently installed on the CG-16 Class ships.

3.5.1 AN/SRC-16( ) Transceiver

3.5.1.1 Background

The AN/SRC-16( ) transceiver includes the AN/SRC-16 (APL 57110800) and the AN/SRC-16A (APL 57110801). The AN/SRC-16 transceiver is used on one ship of the CG-16 Class and all ships in the CG-26 Class. The AN/SRC-16A is used on three ships of the CG-16 Class.

The AN/SRC-16( ) transceiver is a shipboard, single-sideband communications system with a frequency range of 2 to 30 MHz. In addition to the normal voice, continuous wave (CW), and frequency shift keying (FSK) communications, the system provides high-frequency reception and transmission for terminal equipment such as the NTDS. The system operates on four independent channels, with each channel consisting of a single-sideband receiver, a single-sideband transmitter (exciter), and a 500-watt linear power amplifier.

The AN/SRC-16( ) was introduced into the fleet in the 1960s; it utilizes vacuum tubes and electromechanical switches.

3.5.1.2 Discussion

The initial comparison of average man-hours of corrective maintenance per equipment operating year (EOY), (shown in Table 3-6) indicated values of 151.4 and 178.6 for the CG-16 and CG-26 Classes, respectively.

Table 3-6. CORRECTIVE MAINTENANCE BURDEN COMPARISON OF THE HF TRANSCEIVER FOR THE CG-16 AND CG-26 CLASS SHIPS

Equipment	Applicable Ships	Class Population	Total Ship Operating Time (Ship Years)	Ship's Force + IMA Corrective Maintenance Man-Hours	Average Corrective Maintenance Man-Hours per EOY*
CG-16 Class					
AN/SRC-16( )	4	4	27.8	4,216	151.4
AN/SRC-23A(V)	5	10	26.6	781	14.7
CG-26 Class					
AN/SRC-16( )	9	9	60.4	10,783	178.6
AN/SRC-23A(V)	-	-	-	-	-

*EOY = Equipment operating year.

Since the CG-26 Class ships reported approximately 18 percent higher maintenance burden per EOY then the CG-16 Class ships, an analysis of MDS and CASREP data was performed.

The CASREP analysis for the AN/SRC-16( ) HF transceiver on the CG-16 Class ships indicated that four ships submitted a total of 29 CASREPs for the data period 1 January 1972 through 1 September 1978, or 1.3 CASREPs per ship operating year. The number of CASREPs varied from 0 to 3 per ship per year and did not occur at regular intervals. An increasing trend was not indicated in the number of CASREPs against time since overhaul. Sixty-eight percent of the reported downtime was spent awaiting parts. Fifty-two percent (15) of the CASREPs involved problems associated with the RF power amplifier (NSN 2N-5820-00-983-4102). The remaining CASREPs were divided among the following: three for RF tuners (NSN 2N-5821-00-983-4110), five for RF switching units (NSN 2N-5985-00-983-4100), and five for antenna couplers and tank assemblies.

A CASREP analysis for the AN/SRC-16( ) HF transceiver on the CG-26 Class ships indicated 8 ships submitted a total of 65 CASREPs for the data period 1 January 1972 through 1 September 1978, which equates to 1.4 CASREPs per ship operating year. The number of CASREPs varied from 0 to 6 per ship per year and did not occur at regular intervals. An increasing trend was not indicated in the number of CASREPs with time since overhaul. Sixty-two percent of the reported downtime was spent awaiting parts. The most common failure was the RF power amplifier (NSN 2N-5820-00-983-4102), which accounted for 20 CASREPs (31 percent). The remaining CASREPs were divided among the following: 10 for RF tuners (NSN 2N-5821-00-983-4110), 6 for switching units (NSN 2N-5983-983-4100), 15 for antenna couplers, and 14 for other related devices.

MDS data and parts-usage analyses confirmed that the major maintenance actions involved the RF power amplifiers, RF tuners, RF switching units, and antenna couplers. Table 3-7 indicates the high-usage parts for the AN/SRC-16( ) HF transceivers on the CG-16 and CG-26 Class ships. A comparison of best replacement factor (BRF) fleet-wide to best replacement factor experienced (BRF_e) on the CG-16 and CG-26 Class ships indicated that usage of only 4 of 10 equipments exceeded the BRF fleet usage rate. The BRF_e was computed by dividing the annual usage rate by the total part population. Of these 4 equipments, only the RF tuner, NSN 2N-5821-00-983-4110 (on both the CG-16 and CG-26 Class ships), experienced a usage rate significantly greater than the fleet usage rate. Sixty-five RF tuners were replaced on four ships of the CG-16 Class and 245 were replaced on 9 ships of the CG-26 Class which resulted in a BRF of 1.168 and 2.028 for the CG-16 and CG-26 Classes, respectively. The BRF fleet usage is 0.9400. The RF tuner accounted for three CASREPs on the CG-16 Class and ten on the CG-26 Class.

On the basis of this analysis it is evident that the AN/SRC-16( ) HF transceivers on the CG-16 and CG-26 Class ships have used and will continue to use a large quantity of expensive selected parts, as shown in Table 3-7.

Table 3-7. SIGNIFICANT PARTS USAGE OF THE AN/SRC-16( ) HF TRANSCEIVERS FOR THE CG-16 AND CG-26 CLASS SHIPS

NIIN	Nomenclature	Cost per Unit (Dollars)	Quantity per Component	Total Part Population	Number Replaced	Ratio of Parts Replaced to Total Population	Number of Ships Reported	BRF*	BRF_e**
CG-16 Class AN/SRC-16( ) HF Transceiver									
2N-5820-979-5925	Amplifier, Subassembly (4A5)	2,493	2	8	11	1.38	3	0.1300	0.198
2N-5820-979-5927	Electronic, Subassembly (5A2F2)	3,053	5	20	9	0.45	3	1.3000	0.064
2N-5820-983-4096	Tank Assembly	1,940	4	16	4	0.25	1	0.1300	0.036
2N-5820-983-4097	Multicoupler Assembly	2,376	4	16	6	0.38	2	0.1100	0.055
2N-5820-983-4098	Tank Assembly	4,320	5	20	9	0.45	3	0.4500	0.065
2N-5985-983-4100	Switch, RF	3,970	4	16	24	1.50	4	0.2000	0.216
2N-5820-983-4102	Amplifier, RF	2,498	6	24	59	2.46	4	1.3000	0.353
2N-5820-983-4104	Antenna, Coupler	1,072	9	54	78	1.44	4	0.0334	0.207
2N-5821-983-4110	Tuner, RF	2,113	2	8	65	8.13	4	0.9400	1.168
2N-5845-983-4111	Oscillator	1,375	3	12	4	0.33	1	0.1800	0.047
CG-26 Class AN/SRC-16( ) HF Transceiver									
2N-5820-979-5925	Amplifier, Subassembly (4A5)	2,354	2	18	20	1.11	9	0.1300	0.165
2N-5820-979-5927	Electronic, Subassembly (5A2F2)	3,053	5	45	73	1.62	8	0.1300	0.241
2N-5820-983-4096	Tank Assembly	1,940	4	36	27	0.75	7	0.1300	0.112
2N-5820-983-4097	Multicoupler Assembly	2,297	4	36	46	1.28	8	0.1100	0.191
2N-5820-983-4098	Tank Assembly	3,425	5	45	67	1.49	8	0.4500	0.222
2N-5985-983-4100	Switch, RF	3,457	4	36	23	0.64	7	0.2000	0.095
2N-5820-983-4102	Amplifier, RF	2,448	6	54	186	3.44	9	1.3000	0.513
2N-5820-983-4104	Antenna Coupler	1,075	9	81	148	1.83	9	0.0334	0.273
2N-5821-983-4110	Tuner, RF	2,114	2	18	245	13.61	9	0.9400	2.028
2N-5845-983-4111	Oscillator	1,313	3	27	23	0.85	7	0.1800	0.127

*BRF = Best replacement factor from the Navy Ships Parts Control Center *Master Best Replacement Factor List* dated 5/22/78.

**BRF_e = Best replacement factor experience.

$$= \frac{\text{Annual Usage Rate}}{\text{Total Part Population}}$$

The high BRF on items such as the RF power amplifier, amplifier subassembly (4A5), and the RF tuner indicates that this is a common high-part-usage problem with these equipments in the fleet. Although the BRF_e was significantly greater than the BRF for the RF tuner (NSN 2N-5821-00-983-4110), parts availability was not a major problem in the number of CASREPs issued against the RF tuner. Only three CASREPs for the RF tuner were issued during the data period for the CG-16 Class ships, or 0.13 CASREPs per ship operating year. Ten CASREPs were issued for the RF tuner on the CG-26 Class ships for a rate of 0.22 CASREPs per ship operating year. Therefore, the existing allowance parts list is considered adequate.

Discussions with Naval Electronic Systems Engineering Center (NESEC) technical personnel indicated that the AN/SRC-16( ) transceivers are nearing the end of their expected life cycle and are undergoing refurbishment by the manufacturer (Collins Radio Company). Transceivers on three ships (CG-17, -28, and -32) have already received the refurbishment. As previously indicated, the AN/SRC-16( ) transceivers were introduced into the fleet in the 1960s and use vacuum tubes and electromechanical switches. Although this equipment historically received a Class B overhaul at ROH (following more than 10 years of operation), it is predicted that this equipment will require a complete factory refurbishment because the wiring harness can become brittle after years of exposure to the heat generated by vacuum tubes and the mechanical wear experienced by electromechanical switches. It is therefore recommended that factory refurbishment (Class A overhaul) be accomplished at BOH for those ships of the CG-16 and CG-26 Classes that have not previously been accomplished.

The present maintenance strategy of performing the preventive maintenance prescribed by PMS and run-to-failure is adequate to support the AN/SRC-16( ) HF transceivers through the extended operating cycle, provided that these equipments receive a factory refurbishment at or before BOH. Since the factory refurbishment at BOH should reduce the corrective maintenance burden for the AN/SRC-16( ) transceivers for the extended operating cycle, it is predicted that a Class B overhaul after five years of operation will be necessary, because of the age of the equipment (over 15 years) and the design (vacuum tubes of electromechanical switches). Therefore, a Class B overhaul is recommended for follow-on ROH.

Review of the CG-16 and CG-26 Class repair requirements for BOH indicated a requirement for a Class B overhaul for the AN/SRC-16( ) HF transceivers. Because the AN/SRC-16( ) HF transceivers will receive a factory refurbishment (Class A overhaul), it is recommended that the requirement for a Class B overhaul be deleted from the BOH repair requirements.

The AN/SRC-16( ) HF transceivers have a cyclic requirement for the heat exchangers and cabinet blowers to be inspected and repaired as required by a repair facility, in accordance with MIP C-121/4-78. This task is a recommended engineered input to the class maintenance plan to be accomplished at BOH and ROH.

3.5.1.3 Recommendations

The following BOH recommendations apply to the AN/SRC-16( ) on the CG-16 and CG-26 Class ships:

- Refurbishment by the manufacturer of all AN/SRC-16( ) transceivers not previously accomplished
- Deletion of the requirement for a Class B overhaul to the AN/SRC-16 transceivers in the DDEOC BOH repair requirements for the CG-16 and CG-26 Classes

The following recommendations apply to the AN/SRC-16( ) HF transceivers on the CG-16 and CG-26 Class ships and are recommended inputs to the class maintenance plan to be accomplished at ROH:

- Include an engineered task for the shipyard to remove, clean, and test heat exchangers and blower motors in accordance with MIP C-121/4-78
- Include an engineered task for the depot to accomplish a Class B overhaul

3.5.2 AN/SRC-23A(V) Radio Set (CG-16 Class Only)

3.5.2.1 Background

The AN/SRC-23A(V) radio set, used on five ships of the CG-16 Class, consists of eight major units. Two AN/SRC-23A(V) radio sets are used on each ship. The AN/SRC-23A(V) transceiver (APL 57112303CL) consists of the AM-3790A/SRC-23(V) radio frequency amplifier (APL 52379890) and the T-1004/SRC-23(V) radio transmitter (APL 88485894). The AN/SRC-23A(V) is mechanically and electrically similar to the AN/SRC-16.

The AN/SRC-23A(V) radio set is a single-channel HF receiver-transmitter that operates in the frequency range from 2 to 30 MHz. The radio set is automatically tuned and capable of local or remote control in either simplex or duplex operation in amplitude modulation (AM), continuous wave (CW), upper sideband (USD), lower sideband (LSB), frequency shift keying (FSK), voice, or data modes. RF power output is 1 kW.

The AM-3790A/SRC-23(V) radio frequency amplifier is a linear power amplifier providing 1 kW or 500 watts average output power. The 1 kW RF amplifier is intended for continuous operation.

The T-1004/SRC-23(V) radio transmitter is an HF transmitter that operates in the 2 to 30 MHz frequency range and is tuned automatically in 0.1 kHz increments to any one of 280,000 frequency channels. The radio transmitter provides USB, LSB, or independent sideband (ISB) transmission of data or voice messages. The radio transmitter is intended for continuous remote-controlled operation.

The AN/SRC-23A(V) radio set is newer than the AN/SRC-16 and was introduced into the fleet in the early 1970s. This system uses vacuum tubes and electromechanical switches. It performs the same NTDS Link 11 function for five ships in CG-16 Class as the AN/SRC-16( ) performs for the remaining ships in the CG-16 Class and all the ships in the CG-26 Class.

3.5.2.2 Discussion

As shown in Table 3-6, the AN/SRC-23A(V) HF transceiver accounted for 781 ship's force and IMA corrective maintenance man-hours and an average of 14.7 man-hours of corrective maintenance per equipment operating year during the data period 1 January 1970 through 31 December 1977.

Analysis of the MDS data for the AN/SRC-23A(V) indicated that most of the maintenance burden was associated with the RF power amplifier module (NSN 5820-00-111-7152), which is part of the AM-3790A/SRC-23(V) radio frequency amplifier.

A CASREP analysis for the AN/SRC-23A(V) radio set indicated that 28 CASREPs were submitted during the data period 1 January 1972 through 1 September 1978. Twelve of these CASREPs (43 percent) were for the RF power amplifier module (NSN 5820-00-111-7152), 5 for the RF tuner (NSN 5895-00-993-0836), and 11 for such items as power supplies, relays, frequency multipliers, resistors, and a blower motor. Eighty-one percent of the downtime was spent awaiting parts. There was no indication of the number of CASREPs increasing with time since overhaul.

Analysis of parts usage indicated that 29 RF power amplifier modules were replaced by four ships during the data period at an average cost of $4,416 each. As shown in Table 3-8, the BRF_e is less than the BRF and although it appears to be a high-usage item, the BRF_e is still less than normal fleet usage.

A review of the PMS requirements indicated a cyclic requirement to remove, clean, repair, and test heat exchangers and blower assemblies in accordance with MIP TDC-341/2-48. This task is a recommended engineered input to the class maintenance plan, to be accomplished at BOH and ROH.

The existing maintenance strategy for the AN/SRC-23A(V) radio sets consists of performing PMS requirements and, as necessary, restoring the equipment to a specified functional level. The current PMS requirements are adequate.

A review of the DDEOC BOH repair requirements for the CG-16 Class ships indicated a requirement for a Class B overhaul of the AN/SRC-23A(V) radio set. However, because of the relatively low corrective maintenance burden (14.7 average man-hours per equipment operating year) and only 1.4 CASREPs per ship operating year, Class C repairs (as required by POT&I and CSMP results) are recommended for accomplishment at BOH and follow-on ROH. It is therefore recommended that the requirement for a Class B overhaul be deleted from the DDEOC BOH repair requirements.

Table 3-8. SIGNIFICANT PARTS USAGE OF THE AN/SRC-23A(V) TRANSCEIVER

Part Identification		Current Cost per Unit (Dollars)	Quantity per Component	Total Part Population	Number Replaced	Ratio (×100) of Parts Replaced to Total Population	Number of Ships Reported	HF Transceiver	
NSN	Nomenclature							*BRF*	BRF_e*
46E-5820-00-111-7152	RF Power Amplifier Module	4,416.00	1	10	29	2.9	4	0.6600	0.545

*$BRF_e = \frac{\text{Annual Usage Rate}}{\text{Total Part Population}}$

On the basis of the results of this analysis, the AN/SRC-23A(V) radio set on the CG-16 Class ships is expected to perform satisfactorily during the extended operating cycle, provided that the equipment receives those Class C repairs during BOH required by POT&I and CSMP results, the PMS requirements are performed as scheduled, and corrective maintenance is performed as necessary.

3.5.2.3 Recommendations

The following BOH recommendations apply to the AN/SRC-23A(V) radio set on the CG-16 Class ships:

- Accomplish removal, cleaning, repair, and testing of heat exchangers and blower assemblies in accordance with MIP TDC-341/2-48
- Accomplish those Class C repairs of the AN/SRC-23A(V) required by POT&I and CSMP results
- Delete the requirement for Class B overhaul from the DDEOC BOH repair requirements

The following recommendations apply to the AN/SRC-23A(V) radio set on the CG-16 Class ships and are recommended inputs to the class maintenance plan to be accomplished at ROH.

- Include an engineered task for the shipyard to remove, clean, repair, and test heat exchangers and blower assemblies in accordance with MIP TDC-341/2-48
- Include an engineered task for the depot to accomplish those Class C repairs required by POT&I and CSMP results

3.5.3 AN/SRC-31( ) Transceiver

3.5.3.1 Background

The AN/SRC-31( ) is a tactical shipboard transmitter-receiver capable of full-duplex or simplex operation in the 225.00 to 399.95 MHz ultra-high frequency (UHF) range at 50 Hz increments. It can function in Link 11 frequency modulation (FM), Link 4 frequency shift keying (FSK), or voice amplitude modulation (AM) mode. Nominal power output is 375 watts in voice mode and 1,000 watts in data mode, with provisions for a lower power (0 to 200 watts) output in data mode.

There have been three separate models of the AN/SRC-31( ) since its introduction into the fleet: the AN/SRC-31 (APL 57113100), AN/SRC-31A (APL 57113105), and AN/SRC-31B (APL 57113110). The CG-16 Class has two AN/SRC-31A tranceivers installed in CG-16, -17, -18, -19, -21, -22, and -24 and two AN/SRC-31B transceivers in CG-20 and -23, and one AN/SRC-31A and AN/SRC-31B in the CG-18. All the CG-26 Class ships have AN/SRC-31A transceivers installed, one on CG-27 and -34 and two on the remaining ships of the class (CG-26, -28, -29, -30, -32, and -33). AN/SRC-31 transceivers are no longer installed in either class.

Unless otherwise noted throughout this analysis, the AN/SRC-31( ) will be treated as a family of equipments because of their similar functions and physical characteristics, and the small number of AN/SRC-31B transceivers installed.

3.5.3.2 Discussion

Analysis of the MDS data for the reporting period 1 January 1970 through 31 December 1977 (shown in Table 3-9) indicates that ships of the CG-16 Class expended 3,829 maintenance man-hours for the AN/SRC-31( ) for an average of 36.6 corrective maintenance man-hours per equipment operating year (EOY). Ships of the CG-26 Class expended 9,750 maintenance man-hours for the AN/SRC-31( ), for an average of 90.8 corrective maintenance man-hours per EOY. This percentage is almost three times that of the CG-16 Class.

Table 3-9. CORRECTIVE MAINTENANCE BURDEN COMPARISON OF THE AN/SRC-31 TRANSCEIVERS FOR THE CG-16 AND CG-26 CLASS SHIPS

Class	Applicable Ships	Class Population	Total Ship Operating Years (Ship Years)	Ship's Force + IMA Corrective Maintenance Man-Hours	Average Corrective Maintenance Man-Hours per EOY*
CG-16	9	18	52.4	3,829	36.6
CG-26	9	16	60.4	9,750	90.8

*EOY = Equipment operating year.

Review of the CASREP data (Table 3-10) shows that 60 CASREPs were submitted during the data period 1 January 1972 through 1 September 1978 by CG-16 Class ships, for a total downtime of 61,461 hours. Sixty percent of this downtime (36,756 hours) was spent awaiting parts, and 40 percent (24,705 hours) was required for maintenance. The CG-26 Class ships submitted 61 CASREPs for a total downtime of 76,438 hours. Forty-eight percent (36,430 hours) was spent awaiting parts and 52 percent (40,008 hours) for maintenance. Twelve percent (15,121) of the CASREPs were directly related to the high-heat and high-humidity environment in which the AN/SRC-31( ) transceivers are installed. An additional 27 percent (33,121) involved the blowers, servo system, intermediate power amplifier, and power amplifier -- the causes of which could be asssociated with the equipment environmental conditions. The remaining CASREPs were random failures with no particular problems being revealed.

Table 3-10. CASREP DATA SUMMARY FOR THE AN/SRC-31 ( ) TRANSCEIVERS FOR THE DATA PERIOD 1 JANUARY 1972 THROUGH 1 SEPTEMBER 1978

Class	Number of CASREPs	Downtime (Hours)		
		Awaiting Parts	Maintenance	Total
CG-16	60	36,756	24,705	61,461
CG-26	61	36,430	40,008	76,438
Total	121	73,186	64,713	137,899

Discussions with technical personnel from the Naval Electronics Systems Command (NAVELEX) and the Naval Electronics Systems Engineering Activity (NESEA), St. Inigoes, Maryland, indicated that the original requirements for the installation of the AN/SRC-31( ) transceivers did not include environmental control for the spaces in which the equipment was installed. The specifications simply called for a "well-ventilated space." NAVELEX and NESEA technical personnel confirmed that the heat and humidity in the spaces in which the AN/SRC-31( ) transceivers were installed had been a factor in the high maintenance burden experienced by this equipment.

Further discussions with NESEA technical personnel indicated that the AN/SRC-31( ) transceivers on the CG-16 Class ships received field changes early in the data period that improved the reliability of these transceivers. These changes were related to the power supply, frequency standard, and servo system. These field changes should have resulted in a lower maintenance burden on the CG-16 Class. The AN/SRC-31( ) transceivers on the CG-26 Class ships have recently received these field changes, which should also ultimately reduce the burden in this class.

Discussions with NAVELEX technical personnel indicated that the AN/SRC-31( ) transceivers are scheduled for replacement on all CG-16 and CG-26 Class ships at BOH, except the CG-17 and CG-31, which will be replaced at their first ROH after BOH. The replacement of the AN/SRC-31( ) transceivers with the new solid-state AN/URC-93(V) transceivers is part of the NAVELEX UHF growth radio implementation plan (ShipAlts CG-16-1374 and CG-26-0270).

Because the high maintenance burden incurred by the AN/SRC-31( ) transceivers that consist of many discrete components [resistors and capacitors, tubes, transistors, as well as many electromechanical devices (servo motors and gears)], replacement with a new solid-state AN/URC-93(V) transceiver should significantly improvement reliability of the UHF data link and also reduce the maintenance burden. Therefore, it is recommended that replacement of the AN/SRC-31( ) with the AN/URC-93(V) be accomplished on all CG-16 and CG-26 Class ships at BOH, or as soon thereafter as possible.

The respective technical codes indicate that the original plans were to replace all AN/SRC-31( ) transceivers. However, CG-17 and CG-31 Classes will have completed BOH before the AN/URC-93(V)'s availability, and thus the AN/SRC-31( ) currently installed in these two ships will be retained on board. The AN/SRC-31( ) transceivers in these two ships were recently given a Class B overhaul. These equipments are also scheduled to be moved from their present on-board locations to the transmitter room, which is both air-conditioned and humidity-controlled. Moving the AN/SRC-31( ) equipment into the transmitter room should significantly decrease the maintenance burden aboard these two ships, because the equipments will be less susceptible to the environmental problems discussed earlier in this report. However, it is recommended that the AN/SRC-31( ) transceivers in these two ships (CG-17 and CG-31) be replaced with the AN/URC-93(V), in accordance with ShipAlts CG-16-1374 or CG-26-0274 during their first ROH.

The existing maintenance strategy for the AN/SRC-31( ) includes a combination of performing scheduled PMS requirements and, as necessary, restoring the equipment to a given functional level and run-to-failure. Because the AN/SRC-31( ) transceivers remaining on CG-17 and CG-31 were recently updated and given a Class B overhaul, this maintenance strategy and the current PMS program are considered adequate to support the EOC requirements, until such time that the AN/SRC-31( ) in these two ships are replaced with the AN/URC-93(V), in accordance with the appropriate ShipAlts.

3.5.3.3 Recommendations

The following recommendation applies to the AN/SRC-31 transceivers on the CG-16 (except CG-17) and CG-26 (except CG-31) Class ships and should be accomplished at BOH: replace the AN/SRC-31( ) transceiver with the AN/URC-93(V) in accordance with the proposed NAVELEX UHF growth radio program implementation plan (ShipAlts CG-16-1374 and CG-26-0270).

The following recommendation applies to the AN/SRC-31( ) transceiver on the CG-16 and CG-26 Class ships and should be accomplished at ROH: replace the AN/SRC-31( ) transceiver with the AN/URC-93(V) in accordance with ShipAlts CG-16-1374 or CG-26-0270 on all ships in which the replacement was not accomplished during BOH.

3.5.4 AN/USQ-36(V) Data Terminal Set (CG-16 Class Only)

3.5.4.1 Background

The AN/USQ-36(V) data terminal consists of five units: AN/USC-8(V) data modem set, C-6706/U data control, C-6700/U data control-indicator, C-6701/U address control, and C-6702/U address control-indicator. The data terminal provides channeling and control functions for the "A link" of NTDS.

The AN/USQ-36(V) is installed in CG-17 through CG-24 (eight of the nine CG-16 Class ships).

3.5.4.2 Discussion

Analysis of the MDS data reveals that 1,028 corrective maintenance man-hours were expended during the data period 1 January 1970 through 31 December 1977, or an average of 22.6 corrective maintenance man-hours per equipment operating year (EOY). The MDS data further indicated that 41 percent of the equipment problems were discovered "during normal operation", 30 percent during programmed operational and functional appraisals (POFAs) used with PMS or operability tests, and the remaining 29 percent divided between "when lighting off", "during inspection", and "other".

Analysis of the CASREP data indicates that 7 of the 8 ships submitted, a total of 15 CASREPs during the data period 1 January 1972 through 1 September 1978. Thirty-six percent of the downtime (739 hours) was spent awaiting parts, and 64 percent (1,330 hours) was required for maintenance. Seven of the CASREPs were for random card failures, six for failures of equipment to pass POFAs for an unknown reason, one for a blower motor, and one for a worn rack brake assembly. One CASREP remained outstanding at the end of the data period for a rack brake assembly. Although the equipment was operational, the rack brake assembly was considered a safety hazard to both personnel and equipment.

The rack brake assembly keeps the equipment drawer of the AN/USC-8(V) data modem set from completely sliding out of the equipment rack when the drawer is opened for maintenance. It also consists of a hydraulic mechanism that assists in opening and closing the drawer. MDS data indicated that five of the eight ships had experienced problems with this assembly. Failures of the rack brake assembly noted during the analysis indicate the requirement for the addition of a semiannual PMS requirement to check the rack brake assembly for proper operation and inspect the associated cabinet hardware for wear. This requirement can be fulfilled by adding a step to MRC TD-72/S-2, clean and inspect data terminal set; further, it is recommended that this requirement be added to the AN/USQ-36(V) preventive maintenance program (MIP TD-72).

The maintenance strategy for the AN/USQ-36(V) data terminal is based on a combination of on-condition requirements and run-to-failure. On-condition requirements are monitored by POFAs and carried out as part of the equipments' planned maintenance (PMS). As previously noted, 30 percent of the documented maintenance actions for the AN/USQ-36(V) were instituted as a direct result of the PMS-POFA programs, 41 percent as the result of operational failures, and the remaining 29 percent as the result of problems encountered when lighting off during inspection, or classified as "other". Review of the MDS narratives identified 33 percent (12 of 36) of the problems documented in these last three categories as actual operational failures. Therefore, the combination of on-condition (through the PMS-POFA monitoring) and run-to-failure maintenance strategies is considered adequate to support the AN/USQ-36 data terminal during the EOC.

The reviews of the MDS and CASREP data revealed no specific pattern or cause of equipment failure and no difficulty in ship's force maintenance of the equipment. Further, the parts-usage data do not indicate any significant parts usage. It is therefore concluded that the maintenance burden experienced with the AN/USQ-36(V) data terminal is the result of random failures.

Review of the SARP historical maintenance data and MDS data on the AN/USQ-36(V) reveals that no Class B overhauls were requested or accomplished on this equipment, although occasional requests for assistance in accomplishing the equivalent of Class C repairs were indicated (demonstrating that ship's force is capable of maintaining the AN/USQ-36(V) with depot-level Class C repairs).

As a result, is is recommended that the DDEOC BOH repair requirements be revised to reflect that those Class C repairs of the AN/USQ-36(V) data terminal required by CSMP and POT&I results be accomplished during BOH and subsequent ROHs.

3.5.4.3 Recommendations

The following recommendations apply to the AN/USQ-36(V) data terminal set on the CG-16 Class ships and are recommended to be accomplished at BOH:

- Delete the DDEOC requirement for a Class B overhaul on the AN/USQ-36(V)
- Accomplish those depot-level Class C repairs required by CSMP and POT&I results.

The following recommendation applies to the AN/USQ-36(V) data terminal set on the CG-16 Class ships and is recommended for the class maintenance plan to be accomplished at ROH: include a qualified task in the CMP for those depot-level Class C repairs on the AN/USQ-36(V) data terminal set required by CSMP and POT&I results.

The following recommendation applies to the AN/USQ-36(V) data terminal set preventive maintenance program (MIP TD-72) on the CG-16 Class ships: add a semiannual requirement to check the rack brake assembly for proper operation and inspect the associated cabinet mechanical parts for wear; add this requirement as a step to MRC TD-72/S-2, "Clean and Inspect Data Terminal Set".

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the conclusions and recommendations resulting from the review of experience for the CG-16 and CG-26 Navy tactical display systems (NTDS).

4.1 CONCLUSIONS

The following significant conclusions resulted from this ROE:

- Accomplishment of field changes applicable to the display consoles should reduce the corrective maintenance burden and improve system reliability.
- Reduction of the lead time required to obtain some of the replacement parts for the display consoles should reduce cannibalization of consoles.
- Accomplishment of the refurbishment programs for the display consoles and the AN/SRC-16( ) HF transceivers is expected to reduce the corrective maintenance burden for these equipments.
- Replacement of the RD-243/USQ-20(V) magnetic tape recorder with the RD-358(V)/UYK magnetic tape recorder (ShipAlts CG-16-0139 and CG-26-0433) should reduce the corrective maintenance burden and the number of CASREPs, and improve system reliability.
- Replacement of the AN/SRC-31 transceivers with the AN/URC-93(V) transceiver (ShipAlts CG-16-1374 and CG-26-0270) should reduce the corrective maintenance burden and the number of CASREPs, and improve system reliability

Most of the equipments in the NTDS complex are generally reliable and if maintained in accordance with the existing maintenance strategy of performing PMS requirements and "run to failure", are adequate to support the NTDS equipments through an extended operating cycle.

4.2 RECOMMENDATIONS

Corrective actions and planning activities identified by this ROE are categorized as follows:

- Baseline overhaul requirements
- Intracycle maintenance requirements
- Follow-on ROH requirements
- Reliability and maintainability improvements
- IMA improvements
- Depot-level improvements
- PMS changes
- Integrated logistics support (ILS) improvements

Specific recommendations from this review of experience are summarized in Table 4-1.

Table 4-1. SUMMARY OF ROE RECOMMENDATIONS FOR CG-16/26 CLASS NTDS

Component	Recommendation	Reference Subsection
Baseline Overhaul Requirements		
1. Data Display Consoles OA-7979(V)/UYA-4(V) OA-3953/SYA-4(V) OA-3955/SYA-4(V)	Accomplish refurbishment of the display consoles that have not previously been accomplished. If the refurbishment has previously been completed, accomplish those Class C repairs required by POT&I and CSMP results.	3.2.1
2. AM-4534/UYA-4(V) Pulse Amplifier/Symbol Generator	Delete the requirement for a Class B overhaul from the DDEOC repair requirements for the CG-16 Class ships. Accomplish those Class C repairs shown to be necessary by POT&I and CSMP results.	3.2.3
3. CP-642( )/USQ-20 Digital Data Computer	Accomplish those Class C repairs required by CSMP and POT&I results. Remove, clean, repair, and test heat exchangers and blower assemblies in accordance with MIP TD-7/2-87 (CG-16 Class) and MIP TD-7/1-C7 (CG-26 Class).	3.3.1
4. CP-789(V)/UYK Digital Computer	Delete the requirement for a Class B overhaul from the DDEOC requirements and accomplish those overhauls and repairs shown to be necessary by POT&I and CSMP results.	3.3.2
5. RD-243/USQ-20(V) Magnetic Tape Recorder	Delete the requirement for a Class B overhaul from the DDEOC BOH repair requirements.	3.3.3
6. CG-2036(V)/USQ-20(V) Digital Data Converter	Remove, clean, repair, and test heat exchangers and blower assemblies in accordance with MIP TD-50/1-67CL (CG-16 Class) and MIP TD-50/1-C1 (CG-26). Accomplish those Class C repairs required by POT&I and CSMP results.	3.4
7. AN/USQ-36(V) Data Terminal Set	Delete the requirements for a Class B overhaul from the repair requirements for the CG-16 Class ships. Accomplish those Class C repairs required by CSMP and POT&I results.	3.5.4
8. AN/SRC-16( ) Transceiver	Refurbish by the manufacturer all AN/SRC-16( ) transceivers not previously accomplished. Delete the requirement for a Class B overhaul to the AN/SRC-16( ) transceiver in the DDEOC BOH repair requirements for CG-16 and CG-26 Class ships.	3.5.1
9. AN/SRC-23A(V) Radio Set	Remove, clean, repair, and test heat exchangers and blower assemblies in accordance with MIP TDC-341/2-48. Accomplish those Class C repairs indicated by POT&I and CSMP results. Delete the requirement for Class B overhaul from the DDEOC BOH repair requirements for the CG-16 Class ships.	3.5.2
10. AN/SRC-31( ) Transceiver	Replace the AN/SRC-31( ) transceiver with the AN/URC-93(V) transceiver in accordance with the proposed NAVELEX UHF growth radio program implementation plan (ShipAlts CG-16-01374 and CG-26-0270).	3.5.3
Field Changes		
11. Data Display Consoles OA-7979(V)/UYA-4(V) OA-3953/SYA-4(V) OA-3955/SYA-4(V)	Accomplish field change for attenuation of the intensity of the CRT sweep near tube center to prevent burning of the CRT phosphor coating. Accomplish conformal coating of high-voltage modules.	3.2.1
Follow-On ROH Requirements		
12. Data Display Consoles OA-7979(V)/UYA-4(V) OA-3953/SYA-4(V) OA-3955/SYA-4(V)	Accomplish those overhauls and Class C repairs shown to be necessary by POT&I and CSMP results. Remove, clean, and test heat exchangers and blower assemblies for all water-cooled equipment in the data display group in accordance with MIP TD-68/2-A7 (CG-16 Class) and MIP TD-19/1-76 (CG-26 Class).	3.2.1
13. AM-4534/UYA-4(V) Pulse Amplifier/Symbol Generator	Accomplish those Class C repairs shown to be necessary by POT&I and CSMP results.	3.2.3

(continued)

Table 4-1. (continued)

Component	Recommendation	Reference Subsection
	Follow-On ROH Requirements (*continued*)	
14. CP-642( )/USQ-20 Digital Data Computer	Accomplish those Class C repairs required by CSMP and POT&I results. Remove, clean, repair, and test heat exchangers and blower assemblies in accordance with MIP TD-7/2-87 (CG-16 Class) and MIP TD-7/1-C7 (CG-26 Class).	3.3.1
15. CP-789(V)/UYK Digital Computer	Accomplish those overhauls and repairs shown to be necessary by POT&I and CSMP results.	3.3.2
16. RD-358(V)/UYK Magnetic Tape Unit	Remove, clean, repair, and test heat exchangers.	3.3.3
17. CV-2036(V)/USQ-20(V) Digital Data Converter	Remove, clean, repair, and test heat exchangers and blower assemblies in accordance with MIP TD-50/1-67CL (CG-16 Class) and MIP TD-50/1-C1 (CG-26 Class). Accomplish those Class C repairs required by POT&I and CSMP results.	3.4.1
18. AN/USQ-36(V) Data Terminal Set	Accomplish those Class C repairs on the AN/USQ-36(V) required by CSMP and POT&I results.	3.5.4
19. AN/SRC-16( ) Transceiver	Remove the heat exchangers and blower motors for inspection or corrective maintenance as required by a repair facility in accordance with MIP C-121/4-78. Accomplish Class B overhaul of the AN/SRC-16( ) equipment.	3.5.1
20. AN/SRC-23A(V) Radio Set	Remove, clean, repair, and test heat exchangers and blower assemblies in accordance with TDC-341/2-48. Accomplish those Class C repairs required by POT&I and CSMP results.	3.5.2
21. AN/SRC-31( ) Transceiver	Replace the AN/SRC-31( ) transceiver with the AN/URC-93(V) transceiver on all ships in which the replacement was not accomplished during BOH in accordance with ShipAlts CG-16-01374 or CG-26-00270.	3.5.3
	PMS Changes	
22. AN/USQ-36(V) Data Terminal Set	Add semiannual requirement to check rack brake assembly for proper operation and inspect associated cabinet mechanical parts for wear. Recommend that this be added as a step in MRC TD-72/S-2, "Clean and Inspect Data Terminal Set".	3.5.4
	Reliability and Maintainability Improvements	
23. Display Consoles	Accomplish follow-up investigation and monitoring of the high-voltage arcing problem in the high-voltage power supplies and CRT deflection units with the objective of (1) redesigning or relocating the heat exchanger or (2) selecting an alternative method of cooling the consoles.	3.2.1
24. RD-243/USQ-20(V) Magnetic Tape Unit	Replace the RD-243/USQ-20(V) magnetic tape unit with the RD-358(V)/UYK magnetic tape unit in accordance with ShipAlts CG-15-01329 and CG-26-00433.	3.3.3
	Integrated Logistic Support Requirements	
25. Display Consoles OA-7979(V)/UYA-4(V) OA-3953/SYA-4(V) OA-3955/SYA-4(V)	It is recommended that basic analog troubleshooting techniques, high-voltage power supplies, and sweep circuits be emphasized in the training activity for display technicians. It is recommended that the parts support problems for the display consoles be investigated with the objective of reducing the long lead-time required to receive the parts on board. Resolution of this problem should eliminate cannibalization of other consoles and reduce equipment downtime.	3.2.1 3.2.1

LIST OF REFERENCES

The following selected references were used as the basis for the review of experience of the CG-16 and CG-26 Class Navy tactical display systems, SWAB group 410:

1. Generation IV MDS parts and maintenance data for the CG-16 and CG-26 Class for 1 January 1970 through 31 December 1977.
2. *Ship Alteration Information Manual CG-26 Class* (Formerly DLG-26 Class) dated 9/30/77.
3. *Ship Alteration Information Manual CG-16 Class* (Formerly DLG-16 Class) dated 9/30/77.
4. CASREP narrative summaries for 1/1/72 to 9/1/78 for CG-16/26 Class.
5. Technical Manuals:
   - NAVSEA 0967-238-7020, OA-7979(V)/UYA-4(V) Display Consoles
   - NAVSEA 0967-059-2010, OA-3953/SYA-4(V) Data Display Console
   - NAVSEA 0967-059-3010, OA-3955/SYA-4(V) Data Display Console
   - NAVSEA 0967-138-0010, OA-4755/SYA-4(V) Height-Size Video Display Console
   - NAVSEA 0967-238-7040, AM-4534/UYA-4(V) Pulse Amplifier/Symbol Generator
   - NAVSHIPS 0967-308-6010, CP-642B/USQ-20(V) Computer
   - NAVSHIPS 0967-059-5000, CP-789(V)/UYK Computer
   - NAVSHIPS 0967-552-2010, RD-243/USQ-20(V) Signal Data Recorder/ Reproducer
   - NAVSHIPS 0967-086-3010, Communications Centrals AN/SRC-16 and AN/SRC-16A
   - NAVSHIPS 0967-304-2010, Radio Set AN/SRC-23A(V)

   - NAVSHIPS 0967-086-3010, Communications Centrals AN/SRC-16 and AN/SRC-16A
   - NAVSHIPS 0967-304-2010, Radio Set AN/SRC-23A(V)

- NAVELEX 0967-438-1010, Radio Set AN/SRC-31(A) and (B)
- NAVSHIPS 0967-163-8010, AN/USQ-36(V) Data Terminal

6. Trip Report dated 8 January 1979, Ship Visit, USS HALSEY (CG-23)
7. Trip Report dated 14 March 1979, Ship Visit, USS DALE (CG-19)
8. Trip Report dated 21 May 1979, Ship Visit, USS WAINWRIGHT (CG-28)
9. Ship Alteration and Repair Package (SARP) for USS GRIDLEY (CG-21) dated 17 May 1973.